WAR DEPARTMENT

TECHNICAL MANUAL

CLEANING, PRESERVING, LUBRICATING AND WELDING MATERIALS AND SIMILAR ITEMS ISSUED BY THE ORDNANCE DEPARTMENT

August 21, 1941.

TECHNICAL MANUAL)
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WAR DEPARTMENT,
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Prepared under the direction
of the
Chief of Ordnance

SECTION I
GENERAL

1. GENERAL. - a. The purpose of this manual is to present information to the using arms and services concerning the characteristics, application, and handling of cleaning, preserving, lubricating, welding, brazing, cutting, and other materials issued by the Ordnance Department and listed in SNL's K-1 and K-2. Information and directions given herein will supersede those given in TR 1395-A or in the various Ordnance Field Service Circulars published prior to publication of this manual and dealing with materials within its scope.

b. Specific instructions are given in this manual on "Cleaning, Preserving and Lubricating Materials, Recoil Fluids, Special Oils and Similar Items of Issue" as listed in SNL K-1, and on "Welding, Brazing, Cutting, Soldering, and Related Items" as listed in SNL K-2.

2. SCOPE. - a. These regulations cover materials listed in par. 1 b. that are issued by the Ordnance Department for use on or with ordnance materiel.

b. These materials are issued by the Ordnance Department for specific purposes, and care should be taken that they are used for the purposes specified and in the manner prescribed.

c. The use of materials other than those authorized for the specific purposes mentioned is strictly forbidden.

d. Not all of the materials listed in these regulations are authorized for issue to troops. Arsenals and depots of the Ordnance Department and depots at line posts and small ordnance establishments are charged with the preservation of ordnance materiel under storage conditions. Because of the greater magnitude

of this work and the problems of economical preservation over long periods of time, it may be found necessary to use the additional materials listed herein which are not required for issue to troops.

3. REFERENCES. - a. The allowances of cleaning and preserving materials initially issued to the various organizations of the Army are given in Tables of Allowances; those for the units of the National Guard, in National Guard Regulations and circulars; and those for the units of the Reserve Officer's Training Corps and Organized Reserves, in Army Regulations.

b. The unit prices, specification numbers, and packaging of cleaning, preserving and lubricating materials, recoil fluids, special oils, and similar items of issue are given in Ordnance Department Standard Nomenclature List No. K-1. The unit prices, specification numbers, and packaging of welding, brazing, cutting, and soldering materials, and related items are given in Ordnance Department Standard Nomenclature List No. K-2.

c. Instructions for painting and marking of projectiles are covered by standard ordnance drawings (class 75, division 14) and United States Army specifications. To identify service markings of ammunition and ammunition containers, reference should be made to appropriate Technical Manuals and Ordnance drawings.

d. Instructions for the application of lubricants, recoil oils, and preservatives (rust preventive compounds or paints and related materials) are given in detail in the technical manuals covering the particular materials. However, general information applicable to most units will be furnished in this technical manual so far as it is possible to do so.

CLEANERS AND ABRASIVES

SECTION II
CLEANERS AND ABRASIVES

4. AMMONIA, 28%. - a. A colorless solution of ammonia gas in water. Volatile. Strong characteristic odor. Used in making metal fouling solution and ammonia swabbing solution.

CLEANERS AND ABRASIVES

b. When ammunition containing bullets jacketed with copper (gilding metal) is used, ammonia swabbing solution will usually suffice to remove the slight, thin plating of copper on the surface of the bore which sometimes occurs with such ammunition. The bore should first be cleaned with water solution consisting of hot water and issue soap, soda ash solution, hot water alone, or in the absence of these, cold water. After this preliminary cleaning, wet a number of cut flannel patches with the ammonia swabbing solution and swab the bore with these, generally for about 5 minutes, or until the patches no longer show a blue color. Then swab again with clean water, dry thoroughly, and oil with OIL, lubricating, for aircraft instruments and machine guns.

c. Details of the metal fouling solution mentioned above are described in paragraph 26. Methods of preparation and application are given.

d. Soda ash solution mentioned above will be made by adding 1½ spoonfuls (mess kit spoon) of SODA ASH to a pint of water.

e. The ammonia swabbing solution will consist of the following:

28 percent ammonia	1½ parts
Water	1 part

f. Keep in tightly stoppered bottle. Pour out that which is necessary at the time only, and keep the bottle stoppered. This solution is a dilute cleansing solution to be used in rifle barrels following the firing of copper-jacketed bullets and after the barrel has been washed with a solution of soda ash solution (see par. 24-b). Swabbing with this solution on wiping patches should be continued so long as the patch shows a bluish-green stain. Then swab again with clean water, dry thoroughly, and oil. After cupro-nickel bullets have been used, the standard metal-fouling solution is required. (See par. 26).

g. The fumes of AMMONIA, 28%, are not classed as poisonous, but are very irritating to the throat and lungs. It is, however, dangerous if splashed in the eyes, and copious amounts of water should be used if this happens. Fresh air is the proper antidote if nausea or sickening sensation results from over-exposure

to ammonia fumes. Prolonged exposure to the fumes should be avoided by the use of gas masks.

h. Ammonia on the skin causes a smarting and burning sensation. The antidote is washing with copious amounts of water and the application of a light emollient (vaseline, olive oil, lard, or similar grease or oil).

i. If ammonia is kept tightly sealed in its container, it retains its strength indefinitely, but if exposed it evaporates rapidly. So weakened, it may still be used by increasing the percentage of ammonia in the metal-fouling solution until the desired result is attained. A large percentage of ammonia in the solution will do no harm provided the rifle is immediately washed thoroughly with the soda ash solution. Solutions of ammonia kept in glass containers will develop a slight turbidity during prolonged storage. This does not impair the value of the solution as a cleaner. It is, however, an indication that the solution has been slightly weakened and in making up the cleaning solution the ammonia content should be slightly increased accordingly.

5. AMMONIUM CARBONATE. - a. White, hard crystals. Strong odor of ammonia.

b. Used in making metal-fouling solution (see par. 26). On exposure to the air, AMMONIUM CARBONATE loses ammonia and CARBON DIOXIDE, becoming opaque and powdery. Evaporates entirely at 104 F. (40 C.). Very slowly soluble in about four parts water. It is dissolved by acids with the production of foam. Keep in air-tight container in a cool place. Pound the crystals to powder as needed. Long storage prior to use should be avoided.

6. AMMONIUM PERSULPHATE. - a. Colorless, odorless, powdered crystals. Soluble in about two parts water. It decomposes slowly if exposed at ordinary temperatures. A powerful oxidizing agent. Must be used only as directed since it can be dangerous if allowed to come in contact with certain other chemicals.

b. Used in mixing metal-fouling solution (par. 26). Long storage prior to use should be avoided.

7. BURLAP, jute. Used over the bore sponge for cleaning the bores of cannon. Also used for covering the breech and muzzle of cannon in storage or during standby condition.

8. CARBON TETRACHLORIDE. - a. A heavy, volatile, incombustible, colorless liquid with an odor similar to that of chloroform and a vapor that is heavier than air. Used as a solvent for cleaning couplings and spark-plug joints in tanks and combat cars. Pyrene may be used instead, if available. CARBON TETRACHLORIDE is also used as a constituent of the liquid fill for certain types of fire extinguishers and in machine shops as a degreasing solvent. For ordnance purposes, however, SOLVENT, dry cleaning, will be used as a degreasing agent rather than CARBON TETRACHLORIDE.

b. Hazards. - (1) Since CARBON TETRACHLORIDE is incombustible no explosive hazard exists.

(2) If CARBON TETRACHLORIDE is taken into the body by breathing its vapor, or into the digestive system through the mouth it is quite poisonous. The symptoms of poisoning are headache, nausea, anaesthesia, followed by inflammation of the liver and kidneys, and in some cases unconsciousness and death. In contact with the skin, it may cause mild dermatitis. Proper protections should therefore be taken to avoid undue exposure to CARBON TETRACHLORIDE. When used openly, as in a shop, good ventilation must be provided and respiratory equipment furnished to men who work with it for a prolonged period of time. If CARBON TETRACHLORIDE is accidentally gotten into the eyes, it causes considerable pain and produces a violent flow of tears. This effect is temporary, however. The eyes should be immediately washed with copious amounts of water.

9. CLEANER, rifle bore. - a. A combination solvent and preservative which is issued for use by troops in the field for cleaning small bore arms. When CLEANER, rifle bore, is not available the bore should be cleaned with hot soap and water solution, soda ash solution, hot water alone, or in the absence of these, cold water. The bore should be rinsed thoroughly with clean water, dried, and oiled after cleaning with water solutions. When cupro-nickel bullets are used the bore must be cleaned with a metal swabbing solution. (see par. 26).

b. CLEANER, rifle bore, will be used as follows: Saturate a clean patch with CLEANER, rifle bore, and push back and forth through the bore of the rifle or small arm by means of a cleaning rod. Repeat operation with clean patches two or three times and then use a clean dry patch to remove all the cleaner before applying the prescribed OIL, lubricating, for aircraft instruments and machine guns. OIL, engine, SAE 30, will be used to protect the bore if the weapon is to remain out of service for several days and for long-time storage, rust-preventive compound will be used in place of the oil.

10. CLOTH, crocus. - a. Fine, soft, red or reddish-brown powder (tripoli or oxide of iron) on cloth sheets 9 by 11 inches.

b. Used for cleaning and polishing finished (machine-cut) surfaces, such as bolts of rifles and automatic rifles, pistols, breechlocks, parts of breech mechanisms, instruments, gun slides, and brass work.

c. Battery (line) personnel may use CLOTH, crocus for removing rust and stains from threads of breechblocks and breech recesses, gas-check seats, gas-check rings, bearing surfaces of parts of breech mechanisms, and firing mechanisms. It may be used on steel shanks of sight mounts and steel seats of range quadrants. Its use by line organizations on other sighting equipment is prohibited. Do not use any coarser abrasive on gas-check seats. If CLOTH, crocus is not sufficient to remove defects on surfaces specified above, notify the proper ordnance personnel.

d. Ordnance personnel authorized to do such work may use CLOTH, crocus in polishing unlacquered rifle-sight leaves, rifle or machine-gun bolts, the sight-adjusting collars of telescopic tank sights, and the polished piston heads and piston rods of hydro-pneumatic recoil mechanisms.

e. Lacquered parts, such as scales of aiming circles and panoramic sights, must not be polished except when necessary for relacquering. In this case the old LACQUER should be removed with REMOVER, paint and varnish, and the instrument polished only in the event of visible corrosion after removal of the old LACQUER. Removing of old LACQUER, polishing, and relacquering should be

carried out only by ordnance personnel authorized to do so. Strong alkalies such as lye or SODA ASH or strong acids must never be used to clean LACQUER and corrosion products from fire-control equipment.

f. CLOTH, crocus, keeps indefinitely if stored in a fairly dry place.

11. CLOTH, emery. - a. Description. - Natural emery or artificial aluminum oxide abrasive on cotton drill or jean sheets (9 by 11 inches). Grain is printed on each sheet. (Grain 00, 0, ½, 1, 3. No. 00 in fine, No. 3 coarsest.)

b. Uses. - (1) No. 00. - Used for polishing, cleaning, and removing rust from finished iron and steel surfaces in ordinary machine repair. Ordnance personnel authorized to do such work may use No. 00 for the removal of burrs from threads of breechblocks and breech recesses, gas-check split rings and gas-check seats, steel shanks of sight mountings, and bearing sleeves of range finder and B.C. telescope tripods. No. 00 is the coarsest abrasive permitted for work on breech mechanisms. To prevent unnecessary wear, CLOTH, crocus, should be used on these mechanisms. Its use on soft bearing metals--such as brass, bronze, and babbitt--is prohibited, as such bearing surfaces become charged with the abrasive, which then laps away the contacting metal. Emery, however fine, must not be used where particles of the abrasive may enter bores of small arms or bearings of breech mechanisms of any kind. If there is reason to suspect that emery has entered any bearing, the mechanism will be disassembled and thoroughly cleaned. Emery must in no event be used to polish or burnish commutators of generators since emery dust will cause "shorts" and bring about the untimely destruction of the units. Sandpaper of the correct grade (fine) may be used for this purpose, provided the commutator is not too deeply ridged or worn.

(2) No. 0. - Used for cleaning finished iron and steel surfaces other than those specified above, where light deterioration has occurred, and for removing burrs and scratches. May be used on ground and anti-aircraft machine guns, and on gun carriages and artillery accompanying infantry, and for polishing

bayonet blades and other nonbearing finished surfaces where a slight removal of metal does not affect a proper fitting.

(3) No. ½. - Used for cleaning iron and steel surfaces where reasonably heavy deterioration has occurred; also for removing burrs and scratches.

(4) No. 1 (medium). - Used for removing rust, burrs, and other defects from unfinished iron and steel surfaces of light tanks; tractors; antiaircraft, railway, and seacoast artillery; and for preparing them for painting. Its use on finished surfaces is forbidden.

(5) No. 3 (coarse). - Used for removing rust, burrs, and other defects from unfinished surfaces of iron and steel and for preparing them for painting. Its use on finished surfaces is prohibited.

12. CLOTH, wiping, cotton, mixed, sterilized (for machinery). Used as a substitute for cotton waste in shop and in lieu of sponges for washing vehicles. This is an ordinary grade of wiping material. A finer grade of new cloth is required in shops authorized to disassemble recoil mechanisms, fire-control instruments and other precision machines. Cloths are preferable to cotton waste in all operations where deposits of lint are apt to plug oil lines or create stoppages that would lead to trouble. Cloths should always be used in washing operations where strong soap, lye, SODA ASH, or other alkaline agents are used. Sponges will deteriorate rapidly in such solutions.

13. COMPOUND, cleaning. - a. A powder composed of various sodium compounds which removes paint, oil, greases, etc. Oil is removed by a process of emulsification by which the oil is broken up into minute globules and its adhesive properties destroyed so that it is readily rinsed from the surface to be cleaned without formation of bubbly suds. In the emulsifying of oil and grease this compound does not combine chemically with the oil but operates over and over so that a little of it loosens a considerable amount of grease.

b. Used for cleaning quantities of parts which have been covered with rust-preventive compound or caked grease.

c. For washing glass or painted woodwork, ½ to 1 ounce is used in a pail of tepid water. Thorough rinsing must follow the application. Do not use, on optical glass.

d. For cleaning caked grease from metal parts, the compound in water solution is placed in a tank heated preferably by a steam coil and the parts boiled for 10 minutes or longer.

e. COMPOUND, cleaning may be used as a paint and varnish remover for metal parts only as follows: Dissolve 1 pound of cornstarch in 1 gallon warm water. Dissolve 1 to 8 ounces of the compound in 1 gallon boiling water. Add the boiling solution to the cornstarch solution and steam for 2 or 3 minutes. The resulting mixture, when cold, has the consistency of jelly. Apply with a brush and allow it to remain on the painted surface for 5 to 10 minutes. Then scrub with a stiff brush dipped in cornstarch solution. Finally, wash or flush off, using hose and clear water. Never use for cleaning fire-control or other delicate instruments.

14. COMPOUND, cleaning, trisodium phosphate. - a. A white water-soluble compound usually in the form of small needlelike crystals. It will be used as a cleaning compound for washing glassware and painted surfaces. It may also be used to prepare a paint-removing compound as outlined in the paragraph on COMPOUND, cleaning.

b. For washing glassware or for washing painted surfaces, dissolve about half a cup of COMPOUND, cleaning, trisodium phosphate, per gallon of clean water. Painted surfaces should be washed by washing only a small space at a time (approximately 2 sq. ft.), rinsing this as soon as the surface is cleaned, and drying the surface immediately with a clean rag. Failure to follow this procedure will result in stripping an excessive amount of paint from the surface. Rubber gloves should be worn by personnel doing the washing since prolonged exposure to the washing solution will cause reddening and roughening of the hands and attack the fingernails. As a rinse for glassware or windows, clean water with about 2 tablespoonfuls of COMPOUND, cleaning, trisodium phosphate, added per gallon of water is excellent and its use usually makes wiping of glassware unnecessary.

c. Trisodium phosphate must never be used on optical glass and solutions of it should not be left in contact with painted surfaces, paint brushes, sponges, and like materials for more than a very few minutes.

15. COMPOUND, valve grinding. - a. Heavy abrasive paste.

b. Used for grinding valves of gasoline engines and similar work. The coarse grade for rapid, rough grinding; the fine grade for finishing.

16. DECONTAMINATION. - a. Protective measures should be taken as follows:

(1) For materiel which is in constant danger of gas attacks, whether from chemical clouds or chemical shells, care should be taken to keep all unpainted metal parts of the engines, instruments, guns, mountings, and accessories well coated with oil.

(2) Ordinary fabrics made of wool or cotton offer practically no protection against mustard gas. Rubber and oilcloth can be penetrated by mustard if sufficient time is given. In general, it may be said that the greater length of time allowed for penetration, the greater the danger in wearing these articles. For instance, rubber boots which have been worn in an area shelled heavily with mustard gas may be a grave danger to men who wear them several days after the bombardment. Impervious cloth, such as is used in the manufacture of impermeable clothing, will resist penetration by liquid mustard for over an hour, but soon after this time the clothing becomes dangerous. Fabrics which are lightly contaminated may be decontaminated but, if the articles are heavily covered with mustard, they should be destroyed by burying or burning in areas where the fumes driven off by the fire will not affect personnel or animals.

(3) Metal parts of all instruments should be covered with oil and protected with covers when not in actual use, care being taken that the oil does not come in contact with any glass or find its way into the interior of the instruments.

b. Cleaning. All unpainted metal parts of the vehicle and engine, together with all accessories and spare parts exposed to any gas except mustard or lewisite must be cleaned with

SOLVENT, dry cleaning, or ALCOHOL, denatured, and wiped dry as soon as possible after the attack, and in any case within 24 hours, after which they should be again thoroughly coated with oil.

(1) Ammunition should be kept in sealed containers. If exposed to gases corrosion is likely to occur, particularly to brass parts. Exposed ammunition should be cleaned with AGENT, decontaminating, non-corrosive, or, if this is not available, with strong soap and cool water applied with rags and wiped dry with clean rags. Corroded ammunition should either be cleaned thoroughly or discarded. Ammunition containers should be cleaned in the same manner. Do not use dry powdered AGENT, decontaminating (chloride of lime) on or near ammunition supplies as flaming occurs through the use of the chloride of lime on liquid mustard.

c. Decontamination of materiel. The following measures should be taken for the removal of liquid chemicals (mustard, lewisite, etc.) from various materials and equipment (guns, ammunition, web and leather equipment, wood, metals, rope, etc.) which have come in contact with these liquid chemicals.

For all of the operations indicated below a complete suit of impermeable clothing, and a service gas mask, must be worn. Removal of protective clothing should be performed with the assistance of other persons equipped with gas mask and rubber gloves, so as to minimize the danger of getting mustard on the skin. Immediately after the removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. Should any skin areas have come in contact with mustard, cleanse with SOLVENT, dry cleaning; any oil; alcohol; CARBON TETRACHLORIDE, or pyrene prior to taking the soap and water bath. If the face has been exposed to the vapor, or if even a very small drop of mustard gets into an eye, immediate care must be given to prevent serious injury. The eyes should be flooded with plain water, out of a water bottle. Both the insides of the lids and the eyeball must be thoroughly washed. An eye cup, syringe, or dropper will help in this process. Repeat the washing hourly. If vapor has been breathed, treat and handle as a lung irritant casualty

(complete rest and non-alcoholic stimulants). Symptoms arising from contact with mustard appear 2 to 4 hours after exposure. Thorough cleaning, as outlined above, will minimize or completely prevent all symptoms, if done within 20 or 30 minutes after exposure.

Do not attempt to wear the protective suit again until it has been decontaminated. If exposed to vapor only, these garments may be satisfactorily cleaned by hanging in the open air, preferably sunlight, for a couple of days. Clothing exposed to vapor may also be cleaned by steaming for 2 hours. Various kinds of steaming devices can be improvised from materials available in the field. The simplest is merely a large GI can provided with a false bottom which serves to hold the clothing about a foot from the true bottom. Six or eight inches of water is poured into the bottom of the can, the false bottom inserted, and the garments piled in. The can is then placed over a fire, the top covered but not so tightly as to prevent the escape of steam. At least 2 hours should be allowed after steam first appears from around the lid, before clothing should be removed. If the clothing has been splashed with liquid mustard, steaming for 6 to 8 hours will be required.

(1) Commence by freeing the objects of dirt, lumps of earth, and liquid with wooden spatulas, rags, etc., which will be burned or buried immediately after this operation. Care must be taken to protect personnel against vapors arising from burning rags.

(2) Mustard-contaminated metal surfaces that are greased or oiled must first be cleaned with SOLVENT, dry cleaning, or other available solvents for oil, and swabbed with rags attached to ends of sticks. Burn all used rags. Such cleaning removes most of the mustard, but a thin film remains, which must be neutralized. Bleaching solution made by mixing 1 part AGENT, decontaminating (chloride of lime) with 1 part water, painted over all surfaces, is effective. To prevent serious corrosion, do not allow bleaching solution to remain in contact with metal surfaces longer than 1 hour. Remove the bleaching solution by washing with water. After drying, polish and oil all surfaces. The use

of AGENT, decontaminating (chloride of lime) in the dry powder form is not recommended, as it reacts violently with liquid mustard, causing flaming and the formation of a high concentration of mustard vapor.

(3) The exposed surfaces of all instruments and unpainted metal working parts (such as breechblocks, traversing screws, etc.) exposed to mustard or lewisite, must be cleaned with AGENT, decontaminating, noncorrosive, mixed 1 part solid to 15 parts solvent (ACETYLENE TETRACHLORIDE); warm water and soap; ALCOHOL, denatured; or SOLVENT, dry cleaning. Remove all traces of agent or solvent by wiping with clean, dry rags. Bleaching solution must not be used, because of its corrosive action.

Clean instrument lenses as per directions given in par. 18 i. All leather and canvas parts should be thoroughly scrubbed with bleaching solution, or discarded. At the earliest opportunity, coat all metal surfaces with light machine oil. In the event mustard has penetrated into joints of the instrument, the instrument should be replaced at the earliest opportunity and returned to the ordnance personnel for disassembly and thorough cleaning.

(4) Gun bores should be swabbed out with strong soap and water, dried thoroughly, then oiled with OIL, engine, SAE 10.

(5) In the event that AGENT, decontaminating (chloride of lime), is not available, large volumes of hot water may be used to decontaminate materiel. Scrubbing with hot water will wash mustard onto the ground, where it will lie at the bottom of pools and puddles. Therefore, all equipment should be removed from the contaminated area before protective clothing, and particularly the service gas mask, is removed. Such areas should be plainly marked with warning signs before the area is abandoned. After washing equipment in the above manner, it will be necessary to protect all personnel continually against the danger of slow vaporization of mustard from areas not reached by the scrubbing, or from leather, canvas web, etc., particularly during the heat of the day. At the first opportunity, thorough decontamination of all places not accessible by scrubbing and all porous materials should be performed with bleaching solution.

Scrubbing metal surfaces with cold water will remove and partially decompose lewisite. Prolonged contact with water tends to greatly reduce its vesicant properties. As the ultimate decomposition products of lewisite are arsenic compounds, whether chloride of lime or cold water is used in decontaminating, water supplies which drain from a lewisite contaminated area are poisoned and are unfit for consumption by men or animals. Rain falling on equipment formerly contaminated with lewisite and cleaned in the field, will wash sufficient arsenic into the puddles as to make them dangerous for consumption by horses.

d. Transportation of materiel contaminated by chemicals. The removal will be effected by automotive units whenever possible. If horse transport must be used, the route will be carefully reconnoitered in order to avoid contaminated ground. The materiel will be decontaminated as thoroughly as possible before its removal.

e. Special precautions for automotive materiel. - (1) When vehicles have been subjected to clouds of gas with the engine running, it will be necessary to service the air cleaner by removing old oil, flushing with SOLVENT, dry cleaning, and refilling with engine oil of the proper grade.

(2) Instrument panels should be cleansed as outlined in sub par. c (3) above. Seat cushions that have been sprayed with mustard should be discarded. Washing the compartments thoroughly with bleaching solution is the most that can be done in the field. Driving personnel should be on the alert constantly for slow vaporization of mustard, particularly when the equipment gets warm. Contaminated harness should be cleaned carefully before use.

(3) Exterior surfaces of vehicles should be decontaminated with bleaching solution. Repainting may be necessary after this operation.

f. The following references will supply additional information with respect to decontamination.

(1) FM 21-40 Defense against chemical attack
(2) TC No. 38 Decontamination, 1941
(3) TM 3-215 Military Chemistry and Chemical Agents

17. LIME, hydrated (lime slaked and powdered). - a. Used in a solution with lye for the removal of paint from metal parts. Lye burns and develops cracks in wood from which it is almost impossible to remove or neutralize it and after a time begins to destroy the new coat of paint from underneath. The lime and lye solution is considerably cheaper in first cost than REMOVER, paint and varnish. It does not attack rubber or steel as the remover does, but corrodes nonferrous metal parts and must be carefully handled because of the danger of getting it on the clothes, the skin, or in the eyes. It must not be used where it cannot be thoroughly washed off.

b. To prepare the solution for cleaning purposes dissolve 1 pound of SODA, caustic, (lye), (see par. 25) in 6 pints of hot water and add enough lime to give the solution the consistency of paint.

c. Use the solution freshly mixed and apply with a swab of cotton rags, or cotton waste, tied to the end of a stick. When the solution begins to dry on the surface, use a scraper to remove the old paint. Apply two or three times if necessary. Continue the cleaning by washing thoroughly with warm water to stop the action of the lye and lime.

18. PAPER, lens, tissue. - a. A white light tissue paper, used in lieu of PAPER, cleaning, for optical instruments.

b. Used in cleaning lenses and other optical elements of instruments, to remove dirt, lint, moisture, etc. Special care should be taken to keep the paper free from grit, dirt, or dust which might scratch the glass surface. In using this paper in the field the optical surfaces may first be moistened by the breath and the surface then cleaned with the paper. Avoid hard rubbing.

c. No other wiping materials should be used in the field on optical parts of instruments. Chamois skins are objectionable as they quickly gather grit, dirt, or dust, and are liable to scratch the surface. Waste or cloths should not be used, as they are hard, and ordinarily contain grit.

d. In ordnance maintenance shops soft, clean cloths may be used prior to the use of cleaning paper, provided that great care is exercised to keep these cloths free from all kinds of grease, grit, and dust. When a solvent for cleaning glass is required, pure grain alcohol, which on evaporation leaves a perfectly clean surface free from wax or gums of any kind, is best. A water solution containing alkali must never be used for cleaning optical glass since the alkali will attack and rapidly etch the glass.

e. If water is permitted to remain on the surfaces of optical elements a portion of the glass may become etched, leaving pocks or holes in the glass surface. It is, therefore, important to keep optical instruments dry and to store them in dry places.

f. In the presence of grease, dirt, and dust, which ordinarily contain acids, glass is liable to be corroded. This corrosion starts as a film, ordinarily brown in color when viewed by reflected light, which may progress until it covers the whole surface. The formation of this film, of course, interferes with the good optical qualities of an instrument. All kinds of optical glass are susceptible to corrosion, but the prompt removal of moisture and dust and the keeping of glass surfaces perfectly clean and dry will prevent or greatly retard this corrosive action.

g. The removal of lenses and prisms from instruments, for cleaning, is not permitted except by trained ordnance personnel.

h. During storage or while in use, optical parts of instruments must be guarded from heat such as would occur if equipment were exposed to the direct rays of the sun in midsummer.

i. Exposed optical parts of instruments coated with a film of chemicals during gas attacks should be wiped clean with PAPER, lens, tissue. Moisten with the breath and repeat the operation several times if necessary, but rub only gently. If the film is very difficult to remove moisten slightly with ALCOHOL, ethyl, and again rub gently with PAPER, lens, tissue. If this does not properly clean the optics it will be necessary to return the equipment to the ordnance shop for overhaul and repair.

19. PAPER, flint. - a. Crushed flint rock glued to heavy paper sheets size 9 by 11 inches. A particular and very common variety of sandpaper. (Grain No. 00, ½, 1, 1½, 2, 2½.)

b. Uses of various grades:

(1) No. 00 will be used for preparing the surfaces of wooden elements, such as sponge and rammer staves or plotting boards, for varnishing. Use this number for the finest wood finish.

(2) No. ½ is used principally for rubbing preliminary coats of paint to secure a very fine finish in the final coat. It is also used in rubbing down the stocks of small arms for refinishing and is the coarsest grain allowed for this purpose.

When especially desired the grain may be reduced and a very fine paper secured by rubbing two pieces of No. ½ together.

(3) No. 1 is for rubbing preliminary coats of paint to a smoother finish. Nos. 1 and 1½ are used to prepare surfaces to be painted which are in fair condition and only marred in spots.

(4) Nos. 2 and 2½ are used when the surfaces are in bad condition and for removing paint.

c. - (1) No. 00 Grade may be used for sanding the commutators of generators by the proper ordnance personnel. No attempt must be made to condition deeply ridged or badly worn commutators by this method, however.

20. PATCHES, cut (canton flannel). - a. Square pieces, size 2½ by 2½ inches.

b. Used in cleaning and polishing the bores of pistols, revolvers, rifles, and machine guns. The canton-flannel patch has a soft and a hard side. For removing dirt, grease, or rust from a rifle barrel the patch is so assembled to the cleaning rod that the harder side is out; but for drying and polishing the soft (fleecy) side should be out. Only those cleaning rods issued by the Ordnance Department for the purpose may be used.

21. POLISH, metal, paste. - a. Iron-oxide base. A material so fine as to hardly warrant the classification of abrasive.

b. Used in the field for cleaning and polishing brass, bronze, German silver, aluminum, and other bright (unlacquered) parts, to supplement the work of CLOTH, crocus, par. 10.

NOTE: Polishing is prohibited on instruments, sights, scales, and surfaces which are painted, varnished, lacquered, or given such special finish as browning or parkerizing, except as required in refinishing in ordnance shops.

22. SOAP, castile. - a. A neutral soda soap made with vegetable oils only. The bars shrink in storage due to evaporation of moisture. However, its properties other than rate of solution are changed but little during storage.

b. Used in preparation of sponging solution as outlined in par. 28.

c. When a lubricant is required to facilitate the installation of tires, a solution of liquid soap and flake graphite should be used. The liquid soap should be added to the graphite until the resulting solution can be applied with a paint brush. This solution has no deleterious effect on rubber and will retard rim corrosion.

23. SOAP, saddle. - a. Used for cleaning leather equipment. It will be issued in place of SOAP, castile, which is no longer used for this purpose. SOAP, leather equipment, may be used in same manner as SOAP, saddle, provided the latter is not available.

(1) The action of soap depends upon certain physical properties which help in bringing about the mechanical removal of dirt and grease. The soapy water in combination with the grease and dirt forms an emulsion which is easily washed off. Not much of the oil in the leather is removed by the soap since there is little or no chemical action. However, repeated washings will probably necessitate the replacement of oil to prevent the leather from becoming harsh and brittle, since some oil is removed each time the piece is washed.

(2) Nearly all ordnance leather equipment is now russet or fair leather, and when these articles become soiled they should be cleaned by carefully removing all hardened grease with a sliver of wood (not glass or knife), and washed with a sponge saturated with a heavy lather of SOAP, saddle, and clean tepid water. Do not use hot water nor allow the leather to soak in water. Rinse thoroughly and rub vigorously with a dry cloth until the leather is dry. Straps and other articles of unvarnished leather which

become dry and brittle should be cleaned as described, and while the leather is still slightly moist be given an exceedingly light coat of OIL, neat's-foot, by rubbing with a soft cloth moistened (not saturated) with the oil. Wipe off any oil that the leather does not absorb. In cold weather the oil may be heated lukewarm (never hot) before using, and the article after being oiled hung in a warm place. Shellacked sole-leather cases do not require oiling.

Russet leather, as manufactured, is stuffed with a dubbing of codliver oil and tallow, which is absorbed to the extent that the quality of the leather is improved and its life prolonged, but not enough oil remains on the surface to soil the clothing if the equipment is properly cared for. It should be noted that in the washing and oiling described above, if more than a light coat of oil be given, the leather will be greatly darkened and will quickly soil the clothing. No method of cleaning will then restore the original light color of the leather or remove stains from it. Leather equipment must never be washed with strong cleaning solution containing alkali, since alkali has a very deleterious effect on leather goods.

(3) Articles of black leather may be cleaned with SOAP, saddle, and rinsed, and when nearly dry lightly sponged with a mixture of 1 teaspoonful of lampblack in 1 pint of OIL, neat's-foot, the mixture having been first stirred until it has a glossy black appearance. The mixture should then be well rubbed into the leather.

(4) Leather equipment which has become wet should be dried in the shade. Wet leather exposed to the sun or to too high a heat from a stove or radiator becomes hard and brittle.

24. SODA ASH (sodium carbonate). - a. A white, odorless powder, soluble in water but not in alcohol.

b. Used in solution for cleaning bores and breech mechanisms of small arms and cannon and for removing grease and dirt from all types of ordnance material preparatory to painting and wherever a general cleaning solution may be required. To prepare the solution, dissolve ½ to 1 pound (depending upon the strength desired) in 1 gallon of boiling water.

c. In applying the soda-ash solution to the bores of the guns, burlap is wrapped and stitched about the usual bore sponge body, dipped in the solution and forced back and forth in the bore. For small arms the cleaning rod and cut patches are used, the muzzle end of the barrel placed down in a pail of the solution and the cleaning rod drawn back and forth, pumping the solution into and out of the bore. To remove road oil and dirt, small ferrous metal articles may be boiled directly in a tank of the solution which is heated over a fire or by steam. The solution should be mixed and kept, during the using period, in steel containers such as used oil or grease cans that have been wiped clean. Containers of nonferrous metal are strongly attacked by solutions containing this compound and galvanizing will be quickly removed from galvanized buckets by the compound.

d. This material stands storage very well if kept dry.

e. SODA ASH has the effect of softening water by removing calcium and magnesium salts and is used with some boiler installations to condition water and prevent the formation of scale.

25. SODA, caustic (lye) (commercial), for cleaning purposes. - a. A strongly alkaline substance. Absorbs CARBON DIOXIDE and water from the air, consolidating into a solid mass in its container. Soluble in water; freely soluble in alcohol; very caustic, rapidly destroying organic tissue; poison.

b. How Used - (1) With lime to remove paint. (For the preparation of the solution see par. 17.)

(2) At stations equipped with a boiling tank for the removal of paint from metal parts only. The lye is dissolved in water in the proportions of approximately 4 pounds of lye to 15 gallons of water, and the articles are boiled in this solution until the paint is sufficiently loosened to rinse off.

(3) In target paste, for which the following advantages are claimed:

(a) Saving in time, labor, and material, as no boiling is necessary and less flour is used than in other methods.

(b) Lye paste keeps indefinitely without souring or becoming lumpy.

(c) Targets properly pasted with lye paste stand heavy rain, and upon drying show little effect from being wet.

(d) Rats, roaches, etc., will not eat this paste.

c. To mix target paste with lye, into a 30-gallon iron can put 1 level bucketful (3 gallons) of flour, and add 9 gallons of cold water slowly, mixing thoroughly during the addition to avoid the formation of lumps. Dissolve 1 1/2 lb. of issue lye in a 3-gallon bucket of cold water. Pour this slowly into the flour and water mixture, stirring vigorously. Continuing to stir slowly while adding cold water to make up 30 gallons.

d. Caustic soda may also be used to quicken the action of cleaning compounds.

e. Caustic soda, for cleaning purposes, is not for use in recoil mechanisms. SODIUM HYDROXIDE, CP, should be used in the preparation of solutions for recoil mechanisms.

f. (1) Burns caused by caustic soda getting on the skin or in the eyes should be treated at once by washing the injured parts with water, then with a 5 percent solution of boric acid or a 5 percent solution of either acetic acid or vinegar. Dress with vaseline, cottonseed oil, or olive oil, and bandage. If sodium hydroxide splashes into the eyes, flood immediately with a large volume of water. Call a medical officer.

(2) In case a solution of lye is swallowed, give vinegar or lemon juice (preferably vinegar) in large doses, followed by butter, olive oil, or cottonseed oil. Assist vomiting by draughts of tepid water. Call a medical officer.

(3) Lye will destroy woolen clothing. It will corrode nonferrous metals (aluminum, copper, brass, etc.), but its attack on iron or steel is not severe. Keep in a well closed container.

(4) Lye is dangerous to use only when handled carelessly. Precautions should be taken to prevent inhaling small

particles or dust when the dry material is handled and in preventing either the dust or concentrated solutions of lye from reaching the eyes.

(5) Lye solutions must not be kept in containers of nonferrous metal or in steel containers coated with nonferrous metal, such as galvanized buckets. Steel or iron is little affected by strong solutions of lye and old oil drums or steel grease cans properly cleaned make excellent containers for such solutions.

26. SOLUTION, metal fouling. - a. A perishable mixture to be prepared as needed for dissolving cupro-nickel metal fouling from the bores of small arms and machine guns.

(1) The use of metal fouling solution is restricted to ordnance establishments where from time to time it may be found desirable to use it in connection with the overhaul of small arms in which cupro-nickel jacketed projectiles have been used. However, since cupro-nickel jacketed ammunition is no longer standard and its use at the present time is very limited, SOLUTION, metal fouling, will seldom be required in the future.

(2) Serious damage to a weapon may result from improper use of the solution and the directions given herewith must be closely followed.

b. Prepare the solution as follows:

AMMONIUM PERSULPHATE (see par. 6), 1 ounce (2 medium heaping tablespoonfuls).

AMMONIUM CARBONATE (see par. 5), 200 grains (1 heaping tablespoonful.

AMMONIA, 28% (see par. 4), 6 ounces or 3/8 pint (12 tablespoonfuls).

Water, 4 ounces or 1/4 pint (8 tablespoonfuls).

NOTE: The tablespoon referred to is that furnished as part of the mess kit. The foregoing amount is sufficient for about 6 rifle or machinegun barrels.

(1) Powder the AMMONIUM PERSULPHATE and AMMONIUM CARBONATE together (place them inside a clean cloth and grind with a tool handle); dissolve in the water and add the ammonia; mix

thoroughly until about 90 percent of the powder is dissolved; and allow to stand for one hour before using. The solution should be kept in a strong bottle, tightly rubber stoppered, and in a cool place.

c. Cleaning the bore. - (1) Action of primer and powder gases. It has been thought heretofore that corrosion in the bores of small arms might be due to the action of gas actually squeezed into the pores of the metal. Investigation has shown that this is not the case. The bore of a small arm, under the action of pressure and heat of burning powder gases, is hardened in a manner similar to that which forms the so-called case-hardened surface on steel. Under the further action of heat, pressure, and abrasion, the hardened surface becomes covered with minute cracks. These cracks normally follow the tool marks. They extend, however, from the surface of the bore to a depth approximating a maximum of 0.0015 of an inch. These minute cracks accumulate fouling which is difficult to remove by merely wiping, and a bore on superficial cleaning might appear to be in perfect condition, and yet might subsequently rust from the action of fouling and moisture remaining in these cracks.

(2) The firing of a ball cartridge deposits in the bore the products of combustion of the powder and primer, together with plating or smears of metal from the jacket of the bullet. The combustion of the powder, being very complete, usually leaves a fouling which consists of an almost harmless ash. The combustion of the primer mixture, however, results in the deposit of a salt known as potassium chloride, similar to common table salt. This salt is deposited all over the surface of the bore and gas system and in all cracks and tool marks. When first deposited it is harmless, but being hygroscopic it quickly absorbs moisture from the air. Steel rusts very quickly when covered with wet salt. This salt is not dissolved by oil, is little affected by oil or by any solutions or solvents containing oil, and will continue to absorb moisture even when saturated with oil. It is however, readily dissolved in water or in solutions containing water. The proper method of cleaning, therefore, is to dissolve all of this salt from the bore surfaces, cracks, and tool marks with which it comes into contact, by using

water or solutions containing water, then to dry these parts thoroughly, and finally to protect these parts and surfaces with a film of oil or grease. The above facts should be explained to the soldier, and he should be made to understand that oil or solutions containing oil will not clean the bore or gas system free from fouling; that only water or solutions containing water will do this. OIL, sperm, or engine oil should be used to prevent rust in the bore.

(3) Instructions for the insertion of cleaning rods in barrels of small arms, as given in the Technical Manual for any particular arm, generally specify that cleaning rods shall be inserted from the breech end in order that the rifling at the muzzle be not damaged. With the muzzle inserted in a vessel containing hot water and issue soap, soda-ash solution, hot water alone, or in the absence of these, cold water, the cleaning rod with a cloth patch assembled is inserted in the breech and moved forward and back for about one minute, pumping the water in and out of the bore. While the bore is wet a brass or bronze wire brush, if available, should be run through the bore, all the way through, then all the way back, three or four times. Water should then again be pumped through the bore. Then wipe the cleaning rod dry, remove barrel from the water, and using dry, clean flannel patches thoroughly swab the bore until it is perfectly dry and clean. Be careful to see that the chamber is also dried and cleaned, using flannel on a stick if necessary. Then make the examination for metal fouling as described in (4) below. If no metal fouling is present, finally saturate a clean flannel patch with OIL, lubricating, for aircraft instruments and machine guns, and swab the bore and chamber with the patch. finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling,

(4) Metal fouling. - (a) After the bore has been cleaned and dried as above, and before it has been oiled, it should be examined to see if it contains metal fouling. Hold the breech of the barrel pointed toward the sky and examine the bore from the muzzle, the eye about 8 inches from the muzzle. If small smears, flakes, or lumps are seen on the surface of the

bore near the muzzle, or for about 6 inches down from the muzzle, looking like dull lead, this is metal fouling. Metal fouling should be removed at once, as it not only is detrimental to the best accuracy, but the bore will rust very quickly on the portions covered by this fouling.

b. To remove metal fouling proceed as follows: The bore should be free from primer and powder fouling and the barrel should be cold. Place a rubber stopper in the chamber so as to seal the bore at that point. Place a 2 inch section of rubber tube over the muzzle, so that about an inch of the tube extends above the muzzle. Carefully pour the standard metal-fouling solution into the bore from the muzzle until the solution rises in the rubber tube, completely covering the muzzle. If any solution is spilled on the exterior of the barrel, wipe it off at once. The solution should be permitted to remain in the bore from 15 to 20 minutes, but never longer than 30 minutes under any circumstances. The solution should never be used in a hot barrel. Then pour the solution out of the bore and remove the stopper from the chamber and the rubber tube from the muzzle. Allow any remaining solution to drain out of the muzzle, and at once pump water through the bore to remove all trace of the solution. Dry the bore and apply oil or grease as prescribed for regular cleaning. The ammonia solution dissolves the metal fouling. When tracer ammunition has been used it may be necessary to apply the solution three or four times to remove the large amount of metal fouling deposited. It may be necessary at times to use a wire brush in conjunction with metal fouling solution. Bores should be washed out with clean water after each application of metal fouling solution.

(4) The metal fouling solution and ammonia swabbing solution (par. 4) have no appreciable affect on steel when not exposed to the air, but if allowed to evaporate they attack it rapidly. Care should be taken that none spills on the mechanism and that the barrel is washed out promptly. After mixing, the metal fouling solution shall be used within 30 days and should not be used more than twice. Used solution should not be mixed with unused solution but should be bottled separately. The solution is expensive and should be used economically.

27. SPONGES. - a. Either SPONGE, (natural), or SPONGE, unbleached, synthetic, cellulose, may be issued. In either case sponges should be used with very mild cleaning solutions only. For the most part they should be used with soap and water only. Solutions containing trisodium phosphate, SODA ASH, or lye will ruin sponges of either type and rags should be used with such solutions.

b. The cellulose sponge is designed for general maintenance work and may be used for cleaning windows, walls, automobiles, and even for stippling paint. Use of the cellulose sponge will, however, be restricted for the most part to cleaning of leather cavalry equipment and like materials.

28. SOLUTION, sponging. - a. The purpose of this solution is to provide a sponging liquid for use in extinguishing burning residue in the chamber of cannon and also serve to lubricate the breech recess. It is preferred to plain water and will be used in place of compounds previously issued. Water only may be used when the soap solution is not available.

b. This solution is prepared by dissolving 1 pound of SOAP, castile, in 4 gallons of water. Yellow soaps should not be used as they are liable to leave a gummy deposit in the breech recess.

(1) The soap should be shaved from the bar to facilitate dissolving. It should then be added to the water and the water heated until the soap is dissolved. The water should be stirred with as little agitation as possible to prevent foaming.

(2) To avoid the necessity of handling large receptacles, as much soap as is required for all the water to be used can be dissolved in one bucket of water. This concentrated soap solution can then be added to water in other receptacles in the prescribed proportions.

(3) For use during cold weather this solution should be protected from freezing by the addition of glycerin (see par. 28 c (2) below.

c. Sponging saluting guns. (1) A solution of 1 pound of SODA ASH, specification R O-S No. 571, dissolved in 1 gallon of boiling water, is authorized for use as a sponging solution for

saluting guns, the solution to be prepared and used as described in par. 22 b and c.

(2) When the temperature is below 32 F., GLYCERIN, grade A, U.S.P., will be added as indicated in the following table to prevent freezing of the solution:

Minimum temperature	Parts by volume	
F.	Soda ash solution	Glycerin
18	80	20
12	70	30
0	60	40
-14	50	50
-40	40	60

This antifreeze soda ash-water-glycerin solution may be prepared with sufficient accuracy by employing the present issue canteen cup as a measure. This cup holds almost 7/8 quart; approximately 5 cups to the gallon. To make one gallon of the antifreeze solution, the cup may be used as a measure as follows:

Minimum temperature	Cups	
F.	Soda ash solution	Glycerin
18	4	1
12	3½	1½
0	3	2
-14	2½	2½
-40	2	3

d. It will be quite satisfactory to use as an antifreeze sponging solution for cold weather the drainings from recoil mechanisms for which the glycerin-water mixture mentioned in par. 60 has been specified. If such drainings are available it will be necessary only to add 1 pound of SODA ASH per gallon to have the equivalent of the 50-50 solution listed above which is good for minus 14 F.

29. SOLVENT, dry cleaning. - a. A colorless and inflammable liquid distilled from petroleum, used principally as a cleaning and degreasing agent. It evaporates without leaving a corrosion-inducing film and is especially good for cleaning

machines and polished metal surfaces. The inflammable and explosive characteristics of SOLVENT, dry cleaning, are similar to those of kerosene.

b. SOLVENT, dry cleaning, is used for cleaning all metal surfaces of material preparatory to the application of rust-preventive compound. It is generally applied with rag swabs to large parts and as a bath for small parts. It is used with a wire brush in cleaning bores of rifles, to loosen incipient rust, etc. Removal of excess solvent is generally done by wiping with light-colored cloth until no staining of the cloth occurs. To avoid leaving finger marks, which are ordinarily acid and induce corrosion, gloves should be worn by persons handling parts after such cleaning. SOLVENT, dry cleaning, like most petroleum products, will attack and discolor rubber. It is noncorrosive to metal, but for the most careful work and protection of highly machined surfaces against corrosion, it will be necessary to apply corrosion preventive compound or lacquer as the case may be, immediately after cleaning the material with solvent. Solvent may contain traces of water, in which case corrosion will be accelerated. For this reason additional corrosion-preventive measures must be taken immediately after its use. Its continual use without gloves dries the skin, producing cracks. In some cases a mild dermatitis may result from its prolonged contact with the skin.

c. Care is required in handling and storing SOLVENT, dry-cleaning, on account of the fire hazard. In no case should it be poured or allowed to stand in open containers around or near an open fire. Smoking shall be prohibited in the vicinity of or while handling the solvent. Though not quite as dangerous from the standpoint of fire hazard, the same precautions in storage and handling should be followed as those outlined in AR 850-20 for handling gasoline.

d. Gasoline should not be used for the above mentioned cleaning purposes. The increased fire hazard occasioned by its use, together with the toxic nature and corrosion accelerating properties of gasoline containing leaded compounds, is such as to make its use undesirable.

30. WASTE, cotton (two grades, colored and white). - a. The colored cotton waste is used for general cleaning purposes on the exteriors of ordnance material, such as gun carriages and automotive vehicles. It is also used as calking for cracks from which it is desired to exclude dust and dirt.

b. White waste is used for general cleaning purposes on finished surfaces of ordnance material where a better grade than the colored cotton waste is required. In lieu of white cotton waste for certain tank, artillery, and ordnance organizations, an equivalent amount of clean rags may be issued.

31. WASTE, wool, colored. - a. Used for packing the journal boxes of railway artillery and similar heavy bearing boxes. Only the best grade of extra long fiber woolen waste is to be used for this purpose. Waste used in journal boxes must be soaked for at least 48 hours in journal bearing oil at a temperature of not less than 70 F., before being packed into journal boxes.

SECTION III
PRESERVATIVES

32. RUST. - a. General. Rust is a compound of iron formed by the oxidation of iron in the presence of water. There are two kinds, ordinarily known as red rust and black rust. Black rust does not progress under ordinary conditions. Red rust progresses as an infection, thus it is obvious that all red rust must be completely removed from the surface of iron or steel to assure stoppage of rusting. It can be removed by mechanical rubbing or polishing, by sandblasting, or by chemical means. The application of paint or of corrosion preventive compound will retard greatly the progress of rusting. However, the propagation of rust can take place beneath these coatings. If rust has been removed by chemical means, it is most essential that the chemical be neutralized after the work of removing rust is finished and that it be

completely removed and the article thoroughly dried before the rust preventive compound or paint is applied. Sandblasting can, of course, be used only where there is no possibility of the abrasive getting into moving parts during or after the blasting operation. Bearings or bearing surfaces must never be sandblasted.

b. Rust pits. In its earliest stages rust or corrosion may appear as an almost invisible discoloration. This discoloration gradually darkens in color to a yellowish or reddish tinge, and progresses until pits are formed. Pits a thousandth of an inch in depth are plainly visible to the naked eye. Once pits are formed, rusting progresses rapidly around the whole cavity of the pit, and soon a caked mass of iron oxide is projected beyond the surface of the metal. It is highly desirable that rusting be arrested in the beginning stages and that proper protective measures are taken.

33. CORROSION. - a. The rate of corrosion varies with the condition of metal surfaces, highly polished surfaces being much more resistant to corrosion than ordinary machined or rough surfaces. The rate also depends on temperatures, pressures, atmospheric conditions, action of chemicals, chemical composition of the metal and many other factors. Metals ordinarily employed in construction of ordnance materiel are universally subject to corrosion unless protected. In some cases corrosive action is increased under special conditions.

(1) In gun barrels primer fouling collects moisture from the atmosphere. Corrosion is propagated by the salt solution thus formed.

(2) In the case of recoil mechanisms the packing contains free sulphur and small quantities of other compounds corrosive in nature. The gradual breakdown of rubber compounds apparently results in the formation of acids which attack steel. These processes may not be true corrosion but rather the dissolving of metal by acids, or other chemicals, but they are generally included as corrosive problems on account of their similarity thereto.

b. Greases, lubricants, and corrosion preventives are not all stable compounds. In time they decompose, especially in

contact with the atmosphere, with subsequent formation of acids which in turn attack metal. In some cases they absorb water. In either case corrosion takes place under the coating material.

c. Climatic conditions affect "atmospheric corrosion" considerably. Thus corrosion is very slight in dry, arid sections even with high temperature. The rate is very high in the humid sections, and especially so in the warm, humid regions. High humidity is thus considered to be the most important single factor in the development of rust.

The exclusion of air from metal surfaces does not guarantee freedom from corrosion. Both water and oxygen are almost universally present, being dissolved in liquids, greases, etc., in sufficient quantities to rust ferrous metals.

d. Corrosion or the formation of rust is often accelerated by the electrolytic action between the base metal and minute particles of impurities in or on the base metal. This is due to the setting up of an electrolytic cell consisting of the base metal, the impurities, and an electrolyte; the latter being as a rule condensed water vapor made slightly acid with absorbed CARBON DIOXIDE. It is for this reason that moisture must be kept from coming in contact with unprotected metals insofar as it is possible to do so. Due to the corrosion cells, or rather electrolytic cells, that are set up between dissimilar metals, it is necessary to take unusual precautions to prevent corrosion when two different metals are in contact. Thus when aluminum-alloy pistons are in cylinders and separated from steel surfaces by only a small clearance, corrosion may take place even though the metal be separated by oil or grease. Many oils and greases have a tendency to oxidize and form acid, and acids also form in the crankcases of cars from sulphur compounds originating in the gasoline. These decomposition products propagate and accelerate corrosion. The particularly aggresive corrosive action of leaded gasoline, the formation of acids from lubricants and fuels, and the electrolytic action associated with contact of dissimilar metals or impurities in metals make it obvious that the problem of properly protecting automotive or aircraft-type engines is most difficult.

e. Corrosion difficulties may be experienced where wood, packings, etc., are in contact with metal, as these materials may contain water. Packing boxes containing wood shavings and like material should be stored in a dry and protected place. If it is necessary that the material remain packed and in the packing boxes, said boxes should be raised above the floor level at least one inch by inserting wood blocks, short lengths of pipe or similar material under the boxes.

34. INSPECTION FOR CORROSION. - a. For prevention of rust it is highly essential that the methods of examination of metal surfaces be such as to detect rusting in the initial stages. A plain metal surface after thorough cleaning can be best examined under a strong light so reflected to the eye that the details of the surface are well defined. Light discoloration or minute isolated particles of rust are difficult to detect. If discoloration is noted, the presence of minute rust particles can best be determined by a good magnifying glass.

b. For examining bores a mirror with magnification of about 2, mounted on a rod at an angle of about 45 deg, will be found to be excellent. A light should be provided adjacent to the mirror so as to illuminate the surface of the bore under examination, but hidden from the eye of the observer.

c. The surfaces of recuperator bores or those of piston rods of hydropneumatic recuperators must be kept free of corrosion. The formation of pits may result in the condemnation of the parts. It is, therefore, important that the examination and treatment of such surfaces be conducted with the greatest possible care.

d. In the preparation of a surface for examination the rust preventive material should be dissolved with SOLVENT, dry-cleaning, and then the solvent and dissolved material wiped off with a clean cloth. The use of leaded gasoline is prohibited inasmuch as it would induce corrosion, it is toxic, and all gasoline is dangerous to handle from the standpoint of fire hazard. Abrasive or polishing material may remove the evidence of corrosion and therefore will not be used prior to the examination.

35. RUST PREVENTIVES. - a. (1) Although nearly all oils are tested for their corrosive properties, some oils and greases are especially designed for the prevention of corrosion. The materials issued to the service for this purpose are designated COMPOUND, rust preventive, heavy; COMPOUND, rust preventive, light, and COMPOUND, corrosion preventive, aircraft engine.

(2) Remarks concerning corrosion and its prevention apply equally to recoil mechanisms stored filled with liquids. The cleaning of metal surfaces of recoil mechanisms and the elimination of every source of water and oxygen must be conducted with the same degree of care for mechanisms filled with liquids as for those slushed with greases.

b. Rust preventive compounds (previously known as slushing oils, slushing grease, cosmic, or cosmolene). (Heavy and light grades.)

(1) COMPOUND, rust preventive, heavy, is a very viscuous petroleum product used for the protection of finished surfaces during dead storage. It may be heated in a suitable tank so that articles may be coated by dipping. It is inflammable and precautions must be taken to avoid overheating. Temperatures up to 300 F., are safe but not practical.

For use in the protection of materiel for long time storage, the heavy compound should never be thinned by the light compound or by oil. Such mixtures decrease the film strength of the heavy compound and may affect the reaction of the rust inhibiter.

(2) COMPOUND, rust preventive, light. This material is used primarily for short time protection of finished surfaces of all classes. It should not be used on material put in permanent storage or for long time protection. It does not afford as high a degree of protection against corrosion as the heavy compound, but is especially adapted for use by troops because of ease of application and removal. It may be applied with a brush or by dipping, and is easily wiped off. In applying, heating is not necessary except under very cold conditions.

This compound is not a lubricant and should not be used as a lubricant.

(3) COMPOUND, corrosion preventive, aircraft engine, is used for spraying the interior parts of automotive engines and aircraft type tank engines for protection against corrosion during storage. (see AR 850-18).

c. Storage of rust preventive compounds. Rust preventive compounds should be stored in their original containers in such a manner that they can not be contaminated by dirt, water, or foreign substances of any nature. Storage under strong light should be avoided. Grease which has been removed from material being cleaned for reslushing should not be used again, as it will probably contain dirt and other impurities, may have water present, and may have broken down in the presence of air, with the formation of acids.

36. PREPARATION OF METAL SURFACES FOR SLUSHING. - a. The preparation of the metal surface prior to the application of the rust preventive is most important. Probably a very large percentage of corrosion is due to improper cleaning of the metal surfaces before the rust preventive is applied. The metal surface should be clean and dry and free of all traces of corrosion.

In the cleaning of metal and in handling clean metal surfaces, gloves should be worn to protect the metal from acid stains and corrosion resulting from body perspiration.

Grease and dirt may be removed by wiping with rags soaked in SOLVENT, dry cleaning. Special precautions should be taken to see that the solvent is free of water before using. The cleaned surface should be wiped dry.

The preparation of metal surfaces for slushing in heated rooms is excellent practice.

b. Usually the removal of surface rust is best conducted by the use of abrasives or by other mechanical means. If rust has progressed to such an extent that pits are formed, polishing by abrasives, grinding, lapping, or buffing does not remove the rust from the pit. It is possible to dissolve iron rust in acids or specially prepared compounds. This method of chemically cleaning steel surfaces is not ordinarily employed on highly machined or highly polished surfaces, but may be justified under

some conditions. Acids and similar material ordinarily dissolve not only the iron rust but also attack the metal and are objectionable. In case chemicals are used, the greatest care must be taken to remove every trace of acid from the surface of the metal, otherwise later corrosive action may be accelerated beneath the rust preventive. The use of acids or other chemicals to remove rust should not be attempted unless special permission has been obtained.

The removal of surface rust may be satisfactorily accomplished by sandblasting in many instances. Sandblasting must never be resorted to, however, with materiel that is so constructed that sand, emery, or other abrasives might get into bearings, gear cases, or other vulnerable spots. Special permission should be obtained before sandblasting materiel. Soft bearing metals should never be sandblasted inasmuch as part of the abrasive is retained by the metal and will later cut and destroy the working parts with which it comes in contact.

37. PREPARATION OF COMPOUNDS FOR SLUSHING. - a. COMPOUND, rust preventive, heavy, must be made fluid prior to use. A practical method to obtain fluidity is to place container in a vessel of water, heating it to a temperature of about 180 F., the exact temperature being determined by the thickness of the film desired. The higher the temperature of the grease, the thinner is the film applied to the metal. The best temperature is that at which the grease is fluid enough to form a uniform film of the maximum thickness which can be retained on the metal in storage.

(1) The grease should be heated to the temperature at which used for about half an hour before using. Best results will be obtained if the compound is heated slightly above this temperature and then allowed to cool to the desired consistency before using.

(2) During heating, the material should be stirred to eliminate bubbles of air or water vapor. Presence of water will be indicated by frothing on the top of the bath.

38. METHOD OF SLUSHING. - a. A number of different methods of application of heavy compound to the metal have been developed.

The light compound, being very fluid, can be applied without difficulty by rubbing, swabbing, or dipping, care being taken merely to cover the whole surface of the material to be protected and to eliminate air pockets. For heavy compound, application by dipping is most successful. In case dipping is not practicable, swabbing is the preferred method.

b. The dipping process is by far the best method. There is also much less danger of the inclusion of air bubbles in the grease film. The grease film cools after its application to the metal, tightening the film. The film obtained by dipping should be a smooth, silky, regular film of uniform thickness.

Preliminary heating of the material before dipping is good practice, as it drives off a portion of the moisture film which adheres to the surface of the metal. The temperature of the metal when dipped should not be above the temperature of the grease. There is no objection to having the temperature of the surface of the metal at the temperature of the grease, but the body of the metal should be cooler, so as to set the grease film as rapidly as possible after dipping. Otherwise too thin a film will be obtained. If the metal is not given a preliminary heating, it is considered good practice to allow the pieces dipped to remain in the solution for a short time in order to permit absorption of the water film by the grease and to heat the surface of the metal sufficiently for good adhesion.

The desirable thickness of the film is the maximum which will remain on the metal at the maximum temperature to which it is subjected in storage.

Pieces containing bores or cavities should be dipped in such a manner as to allow the easiest escape of air.

After dipping, allow the pieces to drain at room temperature. The drippings are suitable for future use and should not be wasted.

c. In case a swab is used the grease should be heated to a slightly higher temperature than that necessary in dipping, as it cools before reaching the metal surface. In swabbing, several applications of grease are necessary, as the air must be worked out and a uniform coat of grease applied.

A good swab may be constructed by fastening a piece of heavy felt on the end of a pole, wrapping the felt head with several layers of clean wiping cloths free of lint. Burlap is not suitable for use on the highly finished or polished surfaces of recoil mechanisms.

A good grade of cheesecloth is satisfactory. Cloths used on the interior of recoil mechanisms must be soft and free of any substances which might cause scratches.

39. INSPECTION OF CORROSION PREVENTIVE FILM: - a. Since failure of the corrosion preventive film may cause local corrosion, careful inspection of the film is essential. If the corrosion preventive compound is applied at the wrong temperature, a coating that is too thick or one that is too thin will result. Optimum conditions of temperature will be determined by usage and this optimum temperature maintained in applying each specific corrosion preventive compound. In this manner, maximum corrosion preventive measures are carried out with a minimum of waste.

b. If the corrosion preventive compound is raised to too high a temperature or it is too heavy, slippage or running may result. There is also some danger of fire from overheating. Storage of materiel in hot places is therefore to be avoided.

c. Some corrosion preventive films are prone to cracking, especially after they have become old and dried out or excess solvent has been added to the film. Dust and dirt tend to accentuate this condition. Sunlight may also bring about the premature destruction of the corrosion preventive film and precautions should be taken to prevent exposure of material coated with corrosion preventive compound to the rays of the sun. If by visual inspection it is found that cracks have appeared and the metal is exposed, the old corrosion preventive coating must be removed and the material protected with a new coating.

d. An examination of the corrosion preventive film is in itself insufficient for the detection of corrosion. No corrosion preventive compound has yet been developed that will completely stop corrosion.

e. Careful periodical inspection is essential to determine the effective life of a given corrosion preventive film.

f. If dissimilar metals are in contact, separated only by grease or oil films, corrosion must be expected to propagate at a more rapid rate than in other cases. Inspection of metals stored under such conditions should, therefore, be made at more frequent intervals than under normal conditions.

g. In case grease is used between packing and metal surfaces, the moisture or acids which may be contained in the packing may cause failure of the grease film in a comparatively short time. Certain greases decompose in service due to oxidation, with subsequent formation of corrosive end products. Experience will indicate where such conditions are apt to occur and more frequent inspections shall be made accordingly.

40. STORAGE CONDITIONS. - a. Storage conditions must be regulated so as to eliminate every possible source of moisture which might gain access to metal surfaces.

In the protection of interior parts against corrosion, every attempt should be made to seal them against access of air. The strength or elasticity of the seal should be sufficient to withstand the slight increases in interior pressure which may take place under change of atmospheric conditions. It is important that interior surfaces be kept free from change in atmospheric conditions in order to avoid deposition of moisture. Wherever practicable the temperature conditions should be kept constant.

b. In some cases the penetration of moisture may be delayed by the wrapping of the greased article in oiled paper. This method of protection is especially valuable in the case of small articles in tropical climates.

c. If metal surfaces to be protected against corrosion are in direct contact with wooden surfaces, care should be taken to grease the wooden surfaces so as to prevent as much as possible the transmission of moisture from the wood to the metal surface. Green lumber should be avoided. Where wood remains in intimate contact with metal it is a wise precaution to dry the wood thoroughly and then soak it in oil, so as to prevent access of moisture

into the wood; but even in these cases there should be a grease seal formed between the wood and the metal surface.

d. The storage of materiel in tight boxes is good practice, as such boxes keep a large amount of moisture away from the materiel to be protected. Protection afforded by boxes is, of course, dependent on proper storage. Storage of boxes should be in weather proof buildings with stored boxes separated from the flooring at least one inch so as to preclude the possibility of water or solutions from broken containers entering the boxes of material from the floor. The separating medium may be short layers of waste pipe, bricks, or short pieces of wood. The latter is not very satisfactory since it will permit some moisture to be transferred to the packing cases or boxes.

e. Tools. Ordnance maintenance truck tools and ordnance shop tools should be slushed occasionally with OIL, engine, SAE 10, allowed to drain thoroughly and placed in a dry place. The appearance of tarnish or rust spots on the equipment or tools should be taken as a danger signal demanding immediate action. Rust or tarnish spots will be removed with appropriate abrasive material before the slushing operation is accomplished, taking precautions to prevent the entrance of abrasive material into working parts. Complete draining of excess oil will, of course, be accomplished before returning tools and equipment to chests, racks, etc.

(1) More frequent inspection and treatments will be necessary in damp tropical climates.

41. METHOD OF SLUSHING SMALL ARMS. - a. At arsenals the application of rust-preventive compound to small arms follows immediately after the cleaning and consists in dipping the whole rifle, pistol, machine gun, or machine rifle in a heated vat containing COMPOUND, rust preventive, heavy. Usually it is desirable to maintain the temperature as close as possible to 150 F. However, this may not be true for slushing compounds that may be furnished in the future. The rust preventive compound is fluid at the correct dipping temperature and enters all parts of the bolt and magazine mechanism, leaving a thin

film on every surface. As the article stands in a rack after dipping and is still hot, the excess compound runs off, leaving a film which solidifies to such an extent that it does not easily rub off.

b. At Rock Island Arsenal small arms are coated as follows: The barrel is given a coat of rust preventive compound by means of an elevated tank which flows the rust preventive through the barrel, forming a cylindrical coating rather than a plug. It was found that the plug, as it became old, would contract and leave the barrel exposed.

c. All material to be dipped should be clean, dry, and at a temperature of about 70 F., when it enters the dipping bath.

42. METHOD OF SLUSHING RECOIL, COUNTERRECOIL, AND BUFFER MECHANISMS. - a. Recoil, counterrecoil, and buffer mechanisms in use or in standby condition will receive sufficient corrosion protection from the recoil mechanism fluids, and no further treatment, other than the regular inspection by ordnance maintenance personnel, will be necessary.

b. For long time storage where the materiel is not to be kept in standby condition, ordnance personnel authorized to do so will drain the mechanism, thoroughly clean and dry it, and then treat with COMPOUND, rust preventive, heavy.

(1) Mechanisms in which water solutions are used should be drained and flushed with a solution of clear water to which 1/2 lb of SODA ASH has been added per gallon of water. After thoroughly drying, COMPOUND, rust preventive, heavy, may be applied.

(2) Recoil mechanism fluids that may be classified as oil, shall be kept filled with the proper recoil mechanism fluid and no attempt should be made to apply corrosion preventive compound to the interior of the mechanism.

(3) Corrosion preventive compound will be dissolved and removed with SOLVENT, dry cleaning, prior to placing units or materiel in service again.

43. CORROSION PREVENTIVE MEASURES FOR GUNS IN SERVICE.

a. In the hands of troops small arms in use are protected by swabbing the bores with a cloth patch saturated with CLEANER, rifle bore, and then wiping a thin film of OIL, lubricating, for aircraft instruments and machine guns, over all other metal parts. See the technical manual for any particular arm. If the arm is not to be fired for some time the bore must be thoroughly cleaned and COMPOUND, rust-preventive, light, applied.

(1) If the gun is not to remain in service it shall, after proper preparation and cleaning, be treated as follows: Insert the muzzle in melted COMPOUND, rust-preventive, heavy, and fill the bore by pumping with a thong brush attached to a cleaning rod. All other exposed metal surfaces will then be coated by dipping or brushing.

b. (1) Large-bore guns in standby condition shall be cleaned after each firing period with CLEANER, rifle bore, and the surface of the bore coated with COMPOUND, rust-preventive, light. Rust-preventive compound will be applied with swabs and every effort must be made to coat the surface completely.

(2) If the equipment receives almost continuous use, the gun may be protected as follows: After each firing period swab the bore with CLEANER, rifle bore, dry the bore and then swab with OIL, engine, SAE 10.

44. PROTECTION OF MOTOR VEHICLE EQUIPMENT DURING STORAGE. See AR 850-18 on Storage of Motor Vehicles.

45. NAPTHALENE, flake. - a. White crystalline flakes with a strong characteristic odor.

b. For all practical purposes NAPHTHALENE, flake, will be issued to be used as a protective measure against clothes moths. Naphthalene and paradichlorobenzene are both effective against moths when used in sufficient concentration. The recommended concentration is about 1 lb of napthalene per one hundred cu ft. If used in insufficient quantities these materials are not effective and will be useless. The mere odor is not sufficient to kill or repel unless the vapors are present in sufficient quantities.

c. These chemicals are used to prevent damage, by moths, to linings of helmets, felt wads, felt packings of instrument chests, carpet, gun sponges, and paint and varnish brushes. Flakes are sprinkled thickly on the articles, which should, if possible, be then wrapped in paper covers and tightly boxed. Napthalene odor is distasteful to moths, preventing them from laying the eggs which later hatch into the destroying larvae. After the eggs are once laid the naphthalene is of little use. The material should be thoroughly brushed and aired before packing, and should be periodically inspected at least once a year. If moths are prevalent more frequent inspections are necessary, especially during the moth season. If there are any signs of devastation by the moth larvae the articles must be unpacked, cleaned, and recharged with naphthalene. Moth eggs are very small (almost microscopic); the larvae are about the diameter of the head of a common pin and 3/16 to 1/4 inch long.

d. Naphthalene vaporizes and forms a gas which is heavier than air, it should, therefore, be used in air tight receptacles in order to obtain a concentrated naphthalene vapor.

46. PARAFFIN, grade 117-120. - a. PARAFFIN, grade 117-120 will be used in preparation of REMOVER, paint and varnish, and for dipping ends of gun slings to which metal parts are attached. They should be dipped so that the paraffin will extend to a distance of about 1/4 inch beyond juncture of the metal parts. The strap and entire gun slings are placed in bundles and are packed in paper-lined wooden cases.

47. OIL, neat's-foot. - a. A pale yellow oil obtained from hoofs of cattle.

b. Used for the preservation of holsters, gun slings, and other leather equipment furnished by the Ordnance Department. Apply with a small sponge or rag, after having first cleaned the leather with a sponge dampened in lukewarm water, and castile soap. Either natural sponges or cellulose sponges may be used. Rub the oil well into the leather. In cold weather heat the oil until it is lukewarm, but never hot, and hang the article in a warm place. If a polish is desired after the leather is

thoroughly dried, use a perfectly clean sponge and apply a little DRESSING, russet leather.

c. The Ordnance Department issues OIL, neat's foot, for the above purpose only and not for use on harness.

48. SODIUM HYDROXIDE, CP (NaOH), pellets. - a. This compound, which was formerly listed in TR 1395-A as "Soda, caustic" (CP), will be used in the preparation of recoil mechanism fluids, as outlined in par. 80 of this manual. Only the pure grade shall be used inasmuch as impure grades of caustic soda or lye are apt to contain ingredients which would be harmful to the recoil mechanism. The concentration of caustic specified in the formula given in par. 80 must be strictly adhered to. The function of the SODIUM HYDROXIDE is to make the glycerin-water mixture alkaline and thus reduce the tendency for the solution to corrode the mechanism. Alkalinity of the solution may be checked with PAPER, litmus. (see par. 106).

SECTION IV
PAINTS AND RELATED MATERIALS

49. ACETONE, grade B. - a. A colorless inflammable liquid with a characteristic sweetish odor. It is soluble in water and mixes readily with alcohol and ether. Used in preparation of REMOVER, Paint and varnish.

b. Work with acetone or a mixture containing this compound should be carried out in open air or in a well ventilated room.

c. Hazards. Acetone is very volatile and inflammable, forming explosive mixtures with air. This, in addition to its toxic properties, will necessitate extreme caution in its handling and use. Prolonged exposure to fumes of acetone will result in nausea, headache, and eventually chronic disease.

50. BENZENE, (BENZOL), GRADE C. - a. A volatile and inflammable liquid. It is clear and colorless and has an odor similar to that of gasoline. Used in preparation of REMOVER, paint, varnish.

b. Hazards. (1) Vapors of benzene are heavier than air, with which it forms explosive mixtures. It burns with a luminous smoky flame. Frozen benzene is almost as inflammable as liquid benzene.

(2) Toxicity of benzene is as follows: It is a very poisonous substance, acting upon the nervous system and upon the blood-forming organs. It is absorbed into the body by inhaling or through the skin. Mild, acute, benzene poisoning is evidenced by symptoms of excessive fatigue, headaches and nausea. The chronic form of benzene poisoning is characterized by symptoms of intoxication, fatigue, and anemia, followed by convulsions, paralysis, unconsciousness, and possible death.

c. Proper precautionary measures against fire and explosive hazards and against undue exposure to fumes of benzene will be taken in view of its toxic and explosive properties.

51. PAINTS, ENAMELS, AND VARNISHES. - a. Paint is the material upon which chief dependence for protection against corrosion and deterioration of metals and woods must be placed. Many different paints are listed in SNL K-1 and inasmuch as the principles of their application are pretty much the same, details as to the use and application of all of them will not be given herewith. As to color schemes to be followed in the case of such material as munitions or tanks, the equipment for the most part will be painted as issued, providing further painting is necessary. The technical manuals relative to the materiel in question will in most cases give the information wanted.

b. Certain paints adhere to surfaces better than others and furnish a better protective coating. The liquids of the first or base coat should penetrate into the minute depressions or pits in the material and adhere with sufficient tenacity to form a good bond for following coats. Red lead is recognized as one of the best base coats for iron, steel or wood. It possesses no particular advantage, however, as a base coat on nonferrous metals. (metals other than iron and steel).

c. The paints or enamels are issued mixed with liquid and ready to apply except in a few instances. Paints or enamels stored in large containers should be well stirred before transfer to smaller containers. All containers must be kept covered to prevent contact with the air or entrance of foreign matter except when the particular container is being used. Red lead paints do not keep well and must be mixed as needed according to the following formula: 20 pounds of dried red lead per three quarts of MIXTURE, liquid, for red lead paint. The usual method of mixing is to place a small amount of dry lead in a suitable container, work in liquid mixture until a paste is formed, and then add the rest of the liquid mixture and stir thoroughly.

d. Paints and enamels are usually issued ready to apply. Ordnance material is painted before issue and one maintenance coat per year will be ample for protection. With but few exceptions all ordnance materiel shall be painted with ENAMEL, synthetic, olive drab, lusterless, Spec. ES No. 474. This enamel may be applied over old coats of long oil enamel and oil paint previously issued by the Ordnance Department provided, of course, the old coat is in satisfactory condition. Method of application may be by brush or spray. It may be brushed on satisfactorily when used unthinned in the original package consistency or when thinned no more than 5 percent by volume with THINNER, U. S. Army Specification ES No. 370. The enamel will spray satisfactorily when thinned with 15 percent by volume of THINNER, U. S. Army Specification No. ES 370. (Linseed oil must not be used as thinner since it will impart a luster not desired in this enamel.) If sprayed it dries enough for repainting within 1/2 hour and dries hard in 16 hours. Certain exceptions to the regulations

concerning painting exist. Fire-control instruments, for instance, which require the crystalline finish, will not be given the coat of olive-drab enamel.

(1) If the base coat on the material is in poor condition and it is desirable to strip the old paint from the material rather than use sanding and touchup methods, it will be necessary to apply a primer coat.

(2) PRIMER, ground, synthetic, Specification No. ES 360, shall be used on wood as a base coat for synthetic enamel. It may be applied by either brushing or spraying. It will brush satisfactorily as received or after the addition of not more than 5 percent by volume of THINNER, Specification No. ES 370. It will dry to touch in 30 minutes, and hard in 5 to 7 hours. For spraying it may be thinned with not more than 15 percent by volume of THINNER, Specification No. ES 370. Lacquers must not be applied to the PRIMER, ground, synthetic, within less than 48 hours.

(3) PRIMER, synthetic, rust inhibiting, for bare metal, shall be used on metal as a base coat and its use and application is similar to that outlined in par. (2) above.

e. Varnishes and enamels work somewhat stiffer than paint but turpentine may be used only very sparingly since it will destroy the desired gloss. In view of recent regulations prohibiting the use of high-gloss paints or enamels this problem will not be apt to come up. When used too thick on vertical or inclined surfaces, varnishes and enamels may sag, giving a bad appearance. When this occurs, wash off immediately with turpentine before it has had opportunity to set, and thin the paint or enamel with a small amount of turpentine. Removal of paint with REMOVER, paint and varnish, will be necessary if the varnish or enamel becomes hard before turpentine can be applied.

f. The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface, which should be made thoroughly clean, dry, and smooth.

g. All paint should be well stirred before using. Existing stocks of the standard olive-drab paint previously issued may be used up as base coats on old materiel being repainted. It is most necessary in this case to add turpentine to cut the gloss. The final coat must in all events be ENAMEL, synthetic, lusterless, olive drab. The exact and proper thickness of each coat can be learned only by experience. If too thin it often cracks and dries, and if too thick it will become blistered, wrinkled and unsightly. The first coat may, however, be much thinner than any of the succeeding coats.

h. All parts to be painted shall be free from rust, dirt, grease, kerosene, and alkali, and they must be dry. Metal parts may be washed in a liquid solution consisting of 1/2 pound of SODA ASH in 8 quarts of warm water, then rinsed in clear water and wiped thoroughly dry. Wood parts may be treated in the same manner but the alkaline solutions must not be left on for more than a few minutes and the surfaces should be wiped dry as soon as they are washed clean. When artillery or automotive equipment is in fair condition and only marred in spots the bad places should be touched with ENAMEL, synthetic, olive drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with PAPER, flint, No. 1, and a finish coat of ENAMEL, synthetic, olive drab, lusterless, applied and allowed to dry thoroughly before the materiel is used. If materiel is in bad condition, all parts should be thoroughly sanded with No. 2 flint paper and given a coat of PRIMER, ground, synthetic, and permitted to dry for at least 16 hours. It will then be sandpapered with PAPER, flint, No. 00, wiped free from dust and dirt and a final coat of ENAMEL, synthetic, olive drab, lusterless, applied and allowed to dry thoroughly before the materiel is used.

i. After repeated paintings the paint may become so thick as to scale off in places or present an unsightly appearance. It may then be removed for repainting by the use of a lime-and-lye solution or REMOVER, paint and varnish. For formula and method of application of the lime-and-lye solution see par. 17. It is important that every trace of lye, remover, or cleaning compound be rinsed off. Especial attention to this requirement

is necessary in preparing wooden parts because of the porosity of the wood. In addition to the cleaning, woodwork should be properly putty stopped after the priming coat and before the second coat is applied. The putty should be pressed into the crevices or cracks in the wood with the blade of the putty knife and all excess scraped off and the wood sandpapered.

j. Oil cups, grease-gun fittings, alemite fittings, and similar lubricating devices as well as an area three fourths of an inch, more or less, in diameter around each oil hole will be painted red so that they may be readily located.

k. Rammer staves receive one coat of primer, one coat of VARNISH, shellac, orange, and one coat of VARNISH, spar, water resisting. The shellac coat is thoroughly sandpapered before the spar varnish is applied. Target marking disk staves are given one dip in primer and below the disk one coat of spar varnish. The marking disks have a coat of red lead and then disk and adjacent parts of the staff are given one coat of water-resisting red enamel, black target paint, or white target paint as required.

l. Target materiel generally is governed by the policy that wooden parts usually destroyed by bullets will not be painted. Timber frame supports of sliding targets are, however, given one coat of commercial red paint. The pulleys, sash cord and sash-cord clamps, roller brackets, rollers, slide racks, slide irons and hook bolts of sliding targets are not painted. All parts of the car and track of rolling targets for machine guns and all parts of sled targets, except snatch blocks, ropes, staves, and posteboard targets, receive one coat of commercial red paint.

m. Motors of ordnance vehicles shall be painted as required. However, motors received in an unpainted condition must remain in that condition. This applies particularly to radial air-cooled type engines used in tanks in which case painting would impair the heat-transfer efficiency.

n. HELMET, steel, M1917, and HELMET, steel, M1917A1. Helmets shall be clean, free from scale, rust, grease, and dirt. Sandblasting has proven to be a very satisfactory method for preparing the surface of helmets for painting.

(1) Spray the interior of the helmet body with one coat of ENAMEL, synthetic, olive drab, lusterless. Specification No. ES 474.

(2) Spray the exterior of the helmet with one coat of ENAMEL, synthetic, olive drab, lusterless, which has previously been mixed with not less than 8 oz. of ground cork per gallon of enamel. The cork should be mixed in a tank by means of a power driven agitator while the spray operation is being performed. Material in the mixing tank should be under an air-pressure of 8 pounds per square inch and the pressure on the spray guns should be 15 pounds per square inch. If a thinner is required, THINNER, U.S. Army Specification No. ES 370 should be used. In no case should the amount of thinner, used exceed 15 percent by volume of the enamel.

o. The paint on fire-control instruments, panoramic sights, telescopic sights, quadrants, and fuze setters is baked on at the time of manufacture, and these instruments do not require any additional paint in service. If the paint on an instrument becomes marred so that the finish should be renewed, it should be turned in to an arsenal.

p. PAINT, chrome, yellow, shade No. 4. This paint was intended to be used during peacetime only on all ordnance vehicles habitually operated on air fields. These vehicles include the tractor crane, bomb-handling tractor, bomb-handling truck, bomb trailers, and all machine equipment pertaining thereto that is used in the field. At the present time, however, and henceforth until further orders, ENAMEL, synthetic, olive drab, lusterless, will be used on all of these vehicles. As soon as the vehicles that are already in the field and that are painted chrome yellow require repainting, the coat of ENAMEL, synthetic, olive drab, lusterless, will be given as a final coat. The olive-drab coat will be given immediately upon the nation's entering war.

q. At the conclusion of a job of painting, brushes or spraying equipment must be carefully cleaned with TURPENTINE or SOLVENT, dry cleaning, and wrapped in oil paper. Camel's-hair brushes should, after thorough cleaning, be wrapped in a

thin sheet of oil paper and laid flat on a shelf or other clean surface. It is important that the hair of any brush is guarded against distortion while not in use. Worn paint brushes should be retained for use in spreading rust-preventive compound and similar materials. Very old brushes may be used for applying caustic solutions and removing paint. This will result in their quick destruction, however. Any usable paint remaining in the pot should be kept tightly covered. Brushes in semi-continuous use may be suspended in a can of lubricating oil with bristles completely covered with the oil. A brush kept in this manner is ready for immediate use with a minimum of cost in labor or material. The oil should, of course, be drained from the brush and the brush wiped fairly free of oil before the painting operation begins.

r. There are several hazards associated with paint material.

1. Thinners used with paints, varnishes, and enamels are quite toxic. Continued breathing of fumes during or after painting operations must be avoided since they are apt to cause sickness and can cause complete disability or even death. If it is at all practicable painting of materiel should be accomplished in the open air. If it is necessary to paint indoors, ample ventilation must be provided and personnel should not remain in rooms for long periods if fumes from painting are noticeable. Toxic fumes will persist in some cases for many days after painting operations have taken place indoors. For this reason ventilation precautions must be taken for considerable periods after the painting operation has taken place.

2. It must also be kept in mind that many very poisonous compounds are used in paints. Hands should be thoroughly washed before eating, and cuts or wounds on the hands must be kept free of such materials as paints since many of them contain basic lead sulphate, basic lead carbonate, chromium compounds, and other poisonous materials. Lead chromate is particularly poisonous and like other lead paints it may enter the system during eating or handling. Thus eating with dirty paint-covered hands or allowing paint to remain on wounds is a dangerous practice.

Many of the thinners are also poisonous and can enter the system through the skin, breathing of fumes, or through carelessness in handling food. In view of the above, workmen can and should take proper precautions to protect their own health.

3. Fire hazards due to inflammability of paint and paint materials are quite serious. If it is at all practicable, paints should be stored in a steel cabinet in a small building away from the work building. Open cans containing varnish removers, thinners, paints, and similar materials should be kept in covered and tightly sealed cans. Oily or solvent soaked rags should be promptly disposed of after use since if they are stored they may cause fire by spontaneous combustion. In the interests of safety the precautions outlined for the storage of gasoline, in AR 850-20 must also be followed for paint thinners, paint removers, solvents, etc. Empty drums or other containers in which solvents, thinners and similar materials have been shipped are potential killers, since they often contain enough vaporized material of an inflammable nature to cause explosions. Drums or cans should therefore never have heat or flame applied such as in welding or soldering operations unless they are first thoroughly steamed out, filled with water, and all trace of the odor of solvent or thinner removed. Aside from the fact that illness or even death can result from working in confined spaces filled with fumes from solvents, paint thinners and the like, there is the very serious danger of an explosion due to the explosive properties of such fumes when mixed with the proper amount of air.

52. DRIER, liquid paint. (Contains gums or resin, as distinguished from "straight oil driers" not containing gum).

a. Issue of the above is restricted to special conditions. Details will not be given here.

b. Driers are used in paints to hasten the drying of linseed oil which otherwise dries very slowly. Driers, and in less degree turpentine, operate through their ability to absorb oxygen from the air and to transmit this oxygen to the linseed oil. Thus, they work by chemical reactions whereas most mineral spirit thinners mix physically with a paint making it easier

to spread and then evaporate leaving the paint body in its original character. Too much drier burns paint causing it to get too hard and to scale. Ready-mixed paints have the correct amount of drier in them and no more should be added unless the paint has become so old and thick that a comparatively large volume of linseed oil is necessary to thin it. Drier should not be used to thin paints nor should more than 1 percent by volume be used in any case.

53. LACQUER. - a. A rapidly drying weather-resistant coating material. Sets to touch in a few minutes.

b. Clear lacquer is used on sandblasted metal surfaces of fire-control and sighting equipment because of its transparency and to prevent tarnishing and deterioration. Its use for this purpose will be restricted to use by ordnance personnel at maintenance shops or to personnel authorized to work all fire-control equipment. For this reason clear lacquer or thinner will not be issued to troops. The LACQUER, which must be thin enough to flow easily, is applied with a camel's hair brush or sprayed, preferably the latter. The approved thinner is amyl acetate. Alcohol may be used in lieu of amyl acetate but it may be used only sparingly and only when absolutely necessary.

c. The specific applications of the various colored lacquers, with but few exceptions, will be restricted to the personnel of arsenals and ordnance maintenance shops.

54. LEAD, SULPHATE OR CARBONATE. - a. Issued as a white basic sulphate or carbonate paste. Used chiefly as a heavy rust-preventive coating on exposed ferrous (iron or steel) surfaces. Materials used to reduce stiff lead paste to a more workable material will depend on whether a hard-drying or a nondrying covering is desired. For the latter, lubricating oil is used, while for the former, heavy grade rust-preventive compound will give a semi-dried surface. Melted tallow may also be used with the sulphate or carbonate. The white-lead coating is used for the preservation of material stored in stand-by condition or for permanent storage, since it is more adhesive under extremes of temperature than present rust-preventive compounds. White lead paste is also used to lubricate the threads and bodies of bolts

of seacoast carriages, base plugs of empty projectiles, and other threaded parts which remain assembled for long times and are apt to rust together or seize, if not lubricated with some such compounds. Its use on working surfaces where it cannot be readily removed without damaging those surfaces or without unnecessary labor or use of solvents will be prohibited. For the most part, use of white lead will be restricted to use on plugs and threaded joints inasmuch as present corrosion-preventive compounds will protect materiel sufficiently in most climates.

(1) It is desirable as a rule to use basic carbonate since for most purposes it is more satisfactory, it is generally carried in stock, and it can be supplied more promptly.

b. Red-lead paint is used as a base coat on iron and steel parts or ordnance materiel. It must not be used, however, on bearing parts or other working parts of such materiel. It has the effect of slightly etching the surface and so secures a good bond for succeeding coats. It must be mixed as needed since it deteriorates rapidly in the can. The formula for 1 gallon is 20 pounds of LEAD, red, dry, and 3 quarts of MIXTURE, liquid, for red lead paint. Dry material is mixed with a small amount of the liquid mixture into a paste form and then the rest of the liquid mixture is added and mixed.

55. MIXTURE, liquid, for red-lead paint. - a. A mixture of raw linseed oil, pure gum spirit turpentine, and drier. The proportions for 1 gallon of red lead paint are:

5 pints OIL, linseed, raw.
1/2 pint TURPENTINE.
1/2 pint liquid DRIER, liquid paint.
Used mixed with dry red lead.

56. OIL, linseed, raw. - a. Linseed oil will seldom be used in view of recent regulations regarding paint. It must not be used in connection with ENAMEL, synthetic, olive drab, lusterless, since its use here would cause a high luster objectionable during wartime.

b. On gun stocks the oil is applied with a cloth, the surplus oil wiped off, and the stock polished with a clean, dry cloth or the palm of the hand.

c. The boiling of linseed oil increases its ability to absorb oxygen from the air, and thereby quickens the drying, but changes the chemical formula for the oil, introducing objectionable qualities. Moreover, most boiled oil is not actually heated, but treated with chemicals which decrease not only the drying time, but also the useful life of paints in which it is incorporated to such an extent that raw oil only is issued. It is used as an auxiliary thinner for ready-mixed paint, as a polishing oil for stocks of rifles and machine guns, and to treat the inside packing of arm lockers and arm chests.

57. PUTTY (whiting). - a. Used for filling holes and crevices in woodwork before painting. Keep the putty in a can and keep the cover tight, taking out only so much as is needed at a time. If it gets hard, add a drop or two of linseed oil to a mass as large as can be worked in one hand and knead it with the hands or with the putty knife. Too much oil makes putty too soft. When of the right consistency, it works easily under the knife and does not stick to the fingers. If lid has not been properly put on the can and the putty has dried out to the extent that it is hard and brittle, it is useless to waste time and material to work it up again. In cases such as this large quantities of dried-out putty should be returned to the arsenal. Small quantities may be discarded.

58. TURPENTINE. - a. Used for thinning paint, spar varnishes, and asphaltum varnishes. Turpentine will not be used with ENAMEL, synthetic, olive drab, lusterless. Since turpentine will kill the luster it should be used very sparingly where a high luster is desired. A thinner is prescribed for this enamel and should be used.

b. TURPENTINE, in the process of evaporation, absorbs oxygen and has the property of imparting the oxygen to the bodies with which it is associated and in turn causes them to dry. This is not true of petroleum thinners, which simply evaporate.

59. Varnish. - a. VARNISH, shellac, orange; VARNISH, shellac, white; VARNISH, spar, water-resisting and VARNISH, mixing (for aluminum paint) are very much the same with respect to methods of application and use. Generally speaking, the shellacs seal the grain of wood quickly but do not stand weather as well as spar varnish and are not as transparent as the other varnishes listed above. Pure grain alcohol is the best thinner for shellac. White shellac is darkened considerably by contact with iron and where color is important, it should be kept in glass containers and spread with a brush bound with leather or set in rubber. White shellac is a quick drying, transparent varnish used on plotting, range, and deflecting boards as a corrosion preventive coating. Shellacs are used on rammer staves prior to application of a coat of varnish, spar, water-resisting. The latter varnish is used on wooden parts of fire-control instruments, such as tripod legs, and as a finish coat on all wooden rammer staves. TURPENTINE may be used sparingly as a thinner for varnish, spar, water-resisting.

Varnish, mixing (for aluminum paint) shall be mixed with PAINT, aluminum and the resulting mixture used as a primer coat for aluminum surfaces. In view of the shortage of aluminum, the use of PAINT, aluminum is restricted to the priming of aluminum surfaces.

60. REMOVER, paint and varnish. - a. A toxic and explosive liquid mixture consisting of benzine, acetone, ethyl alcohol and paraffin. This mixture is inflammable and quite volatile. The fire hazard is great and smoking will be prohibited while it is being used and as long thereafter as the fumes persist. It is also quite toxic and continued exposure to the fumes in poorly ventilated rooms will lead to headaches, nausea, and eventually to chronic ailments and even death. Contact with the hands or other portions of the body should be avoided, since these chemicals cause a stubborn rash to appear on the skin of some people. Proper precautions should therefore be taken to protect personnel using REMOVER, paint and varnish.

b. It is used to dissolve old paint and varnish from wooden parts of materiel or whenever it is impracticable to use the lime-and-lye solution. (par. 17). As a cleaner for wood it does

not check or crack the surface, and as water is not required to wash it off the grain of the wood is not raised.

c. Apply the remover, as it comes from the can, very liberally but slowly with a 3 in. or 4 in. varnish brush, using a single or one-way stroke only. Brushing out or over several times seems to seal the surface so that the remover does not have its best effect. Allow the remover to remain on until the oil paint or varnish may be wiped or scraped off. Do not start scraping before it is loose. Wash all the paint and varnish remover off with SOLVENT, dry cleaning, before applying new paint. Wash the brush with SOLVENT, dry cleaning, and dry it before putting it into fresh paint or varnish.

d. Keep paint remover out of any finished joint or bearing from which it cannot be thoroughly cleaned. It attacks rubber and should be kept away from insulated wires. It is well not to get any of the remover on the hands, as most brands have poisonous qualities tending to produce a dermatitis as well as to dry and crack the skin. Bear in mind the fire hazard when using.

SECTION V
LUBRICANTS

61. GENERAL. The following general instructions on care of lubricants should be rigidly followed:

a. All lubricant containers must be kept closed so as to preclude the possibility of grit, dirt, lint, and other foreign materials getting into lubricants. Rapid wearing and even immediate destruction of parts may result from the use of lubricants which contain abrasives or other foreign matter. Not only should containers be kept closed when lubricant is not actually being removed but they should also not be opened when sand and grit may be blown into them.

b. Prompt removal and disposal of oily rags and papers must be accomplished since an accumulation of such material may

cause a fire by spontaneous combustion. The use of too much lubricant must be avoided. It should be kept in mind for instance, that ball bearings should be filled about 1/2 full and never more than 2/3 full of the recommended grease. The use of excessive lubricant in this instance will cause over heating of the bearings and may cause the premature destruction of the material. It is strongly recommended that the exact quantities and grades of lubricants recommended in Technical Manuals, Manufacturer's Catalogs and like publications be rigidly followed.

c. Notes given in the back of SNL K-1 will supplement information on lubricants given in this manual.

62. GRAPHITE, flake. - a. Used mixed with lubricating cup grease No. 5 in the proportion, by volume, of flake graphite 1 part, cup grease 5 parts, as a substitute for hard graphite lubricating grease. Its use for the most part has been discontinued in lieu of better and more modern lubricants. It will be used now only as a substitute or an emergency lubricant.

b. GRAPHITE, powdered. This material is usually mixed with No. 3 cup grease for use on liner seats in tubes of antiaircraft guns with removable liners. The mixture is composed of 1 pound of grease to 1 ounce of powdered graphite. A thin coating is applied.

(1) Used for lubricating bearing surfaces of targets.

(2) Used in the compression grease cups on heavy-duty bearings, such as the trunnions of the major-caliber guns comprising seacoast and railway artillery. It is not to be used on roller or ball bearings or on gun-roller paths since on such surfaces transparent greases are more desirable in order that rust may be detected when first formed.

63. GREASE, graphite, soft (aircraft). - a. A soft, black grease used for lubricating and slushing sprocket chains, counterrecoil springs, chest-carrying springs, and similar large springs on artillery materiel. Graphite establishes on finished metal surfaces a thin film not easily washed off by rain. This grease is therefore especially valuable on bearing surfaces exposed to the weather, such as gun slides and elevating arcs of light and

medium artillery. It should not, however, be used on ball or roller bearings.

64. GENERAL LUBRICATION INSTRUCTIONS FOR SMALL ARMS. - a. In the event that field manuals giving lubrication instructions for a particular small arm weapon are not available, and such instructions are not available in technical manuals on the materiel, the following general instructions shall be followed. These instructions apply to the weapons listed in b. below.

b. The following small arms are considered in these instructions:

(1) PISTOL, automatic, caliber .45, M1911.

(2) PISTOL, automatic, caliber .45, M1911A1.

(3) RIFLE, U.S., caliber .30, M1.

(4) RIFLE, automatic, Browning, caliber .30, M1918.

(5) RIFLE, automatic, Browning, caliber .30, M1918A2.

(6) GUN, machine, Browning, aircraft, caliber .30, M2, fixed.

(7) GUN, machine, Browning, aircraft, caliber .30, M2, flexible.

(8) GUN, machine, Browning, caliber .50, M2, water-cooled, fixed.

(9) GUN, machine, Browning, caliber .50, M2, water-cooled, flexible.

c. The following lubricants, cleaning materials, antifreeze mixtures and rust preventive compounds are prescribed:

(1) OIL, lubricating, for aircraft instruments and machine guns.

(2) CLEANER, rifle bore.

(3) SOLVENT, dry-cleaning.

(4) ETHYLENE GLYCOL

(5) COMPOUND, rust preventive, light.

(6) OIL, sperm

d. Small arms:

(1) When weapons are received from storage, they should be thoroughly cleaned of all rust preventive compound with SOLVENT, dry-cleaning, and immediately oiled, as outlined below.

(2) For all weapons fired on the ground at atmospheric temperatures above 45 F., use OIL, sperm. If this oil is not available, OIL, engine, SAE 10, or any light grade machine oil may be used in an emergency. Oil working parts sparingly. Apply lubricant to exposed surfaces with an oily rag and to the bore with a cleaning rod and cloth patch inserted from the breech end.

(3) For the PISTOL, automatic, caliber .45, M1911 and M1911A1, the RIFLE, caliber .30, M1, and the RIFLE, automatic caliber .30, M1918 and M1918A2 at temperatures between 0° F. and 45 F., use OIL, lubricating, for aircraft instruments and machine guns. The lubricant is best applied with a slightly oiled cloth.

(4) For the Pistol, automatic, caliber .45, M1911 and M1911A1, at temperatures below 0° F., all oil should be removed with SOLVENT, dry-cleaning, and the weapon used without oil.

(5) The RIFLE, U.S., caliber .30, M1 and the Rifle, automatic, Browning, caliber .30, M1918 and M1918A2, at temperatures below 0° F., are oiled with OIL, lubricating, for aircraft instruments and machine guns, only on the parts which show signs of wear.

(6) All types of machine guns fired on the ground at temperatures below 45 F., are lubricated with OIL, lubricating, for aircraft instruments and machine guns. Special care should be taken not to use excess oil. The parts are best oiled by wiping with a slightly oiled cloth.

(7) Aircraft machine guns, when fired in the air, should be lubricated with OIL, lubricating, for aircraft instrument and machine guns, regardless of the atmospheric temperature near the ground.

(8) The bores of all small weapons should be thoroughly cleaned after use with CLEANER, rifle bore, and immediately re-oiled to prevent rust. In the event that CLEANER, rifle bore,

is not available, but soapy water or a hot water solution of SODA ASH (1 1/2 spoonfuls per pint of water), or even plain hot water, may be used.

CAUTION: OIL, lubricating, for aircraft instruments and machine guns, is not a rust preventive. OIL, sperm, or OIL, engine, SAE 10, should be used for protecting weapons if they are to be left more than forty-eight (48) hours without flying. For prolonged storage, the weapon should be protected with COMPOUND, rust preventive, light.

(9) In cold climates, weapons should be thoroughly cleaned and oiled immediately upon bringing indoors because moisture condensing on the cold metal in a warm room will cause rusting. After the weapons reach room temperature, they should be wiped free of condensed water vapor and oiled again.

(10) OIL, lubricating, for aircraft instruments and machine guns will be used in the buffer mechanism of the GUN, machine, Browning, caliber .50, M2, water cooled, fixed, and the GUN, machine, Browning, caliber .50, M2, water-cooled, flexible.

65. GENERAL LUBRICATION INSTRUCTIONS FOR ARTILLERY. - a. In case of conflict between the following information on care and preservation of artillery the specific information given in Field Manuals or Technical Manuals, for the particular piece of materiel, should be followed.

b. OIL, lubricating, gear, chain and wire rope, shall be used to lubricate and protect gears, chains and wire ropes on loading mechanisms and similar equipment.

c. GREASE, graphite, soft (aircraft), shall be used for lubricating and flushing sprocket chains, counterrecoil springs, chest-carrying springs, and similar large springs on heavy seacoast artillery materiel. In climates where the prevailing temperatures are below zero it will be necessary to thin the above lubricant by slushing equipment with OIL, engine, SAE 10, or in the event of sub-arctic temperatures the grease should be cleaned from the equipment and OIL, engine, SAE 10, used to replace the graphite grease as a lubricant. It is most necessary to exercise

the equipment frequently. This means the working and operation of all moving parts without actually firing the gun. Operation of the equipment should occur at least once per week in ordinary climates and more frequently when lower temperatures prevail.

d. Heavy anti-friction bearings shall be packed with GREASE, O.D. No. 0. In tropical climates GREASE, O.D. No. 1 should be used.

e. All sealed gear cases shall be cleaned and filled with OIL, engine, SAE 10, if the prevailing temperatures are below 32 F. Above this temperature, OIL, engine, SAE 30, shall be used. In tropical climates OIL, engine, SAE 30, should be used during all seasons. Frequent checks for leakage or loss of lubricant from the gear case must be made. An exception to this will be made in the case of hydraulic variable-speed gears. OIL, hydraulic, USA specification 2-79, shall be used with such gears.

f. Detailed information as to the lubrication of wheel bearings and similar parts of mobile artillery units is given in the technical manuals covering each type of gun. See also TM 4-245 on Preservation and Care of Seacoast Defense Materiel.

66. GENERAL LUBRICATION INSTRUCTIONS FOR FIRE CONTROL INSTRUMENTS. - a. All parts of fire control instruments (except antiaircraft directors and sound locators) for which solid or semi-fluid greases or petrolatum have been recommended, henceforth will be lubricated with GREASE, special, low temperature. All parts of fire control instruments requiring oil will be lubricated with OIL, lubricating, for aircraft instruments and machine guns. It is important that the oil should be applied carefully and diligently. Extreme care should be taken not to overlubricate fire control instruments.

b. Detailed instructions for the care and preservation of antiaircraft directors and sound locators are as follows:

(1) The following lubricants and cleaning materials are prescribed:

(a) GREASE, special, high temperature.
(b) OIL, lubricating, for aircraft instruments and machine guns.

(c) SOLVENT, dry-cleaning.

(2) Directors in service will be taken into a dust-free room every six months for inspection and lubrication. After the four side cover plates have been removed, the instrument will be inspected and certain of its parts lubricated. The ballistic cams will be cleaned with SOLVENT, dry-cleaning, and wiped with a soft dry cloth. After being cleaned, the cam surfaces will not be touched with the bare hands as the natural body acids will cause stains. Extreme care shall be used in handling so as not to permit the cams to strike any metallic object which might injure the surfaces. A light coating of fresh grease will be applied on the cam surfaces with a stiff brush and the cams replaced in the director. GREASE, special, high temperature, will be used on the cams and in all other places requiring grease only.

(3) All bearings and points of sliding friction that are accessible from the four sides of the director should be inspected. All ball bearings, at the time of assembly, are coated first with a few drops of OIL, lubricating, for aircraft instruments and machine guns, and then with grease. Ordinarily, these bearings will require no attention while in service. If the ball bearings appear dry, grease shall be applied in accordance with par. 3.

NOTE: Grease is applied to the ball bearings as a protection against rusting, therefore, only a thin film is required for this purpose. Excessive greasing will clog the ball bearings and may retard the speed of the shafts or cause complete stoppage of the instrument.

(4) A light coating of GREASE, special, high temperature, shall be applied to all machined surfaces that are not protected by permanent protective films, even though they have no working surfaces.

(5) The lead screws of the range and altitude stops and the future altitude lead screw adjacent to the ballistic cam carriage shall be greased with GREASE, special, high temperature.

(6) The slip clutches in the drive from the altitude, range, and angular height handwheels should be inspected. If

necessary, the friction disks should be given a light application of GREASE, special, high temperature, and the clutches readjusted to slip at the stops.

(7) Differential gears, gear drives, ball bearings, etc., may be lubricated with a drop or two of OIL, lubricating, for aircraft instruments and machine guns, if dry. Do not oil excessively.

(8) Periodically (at intervals determined by service conditions) the side cover plates, cam, and cam carriage should be removed and the thrust bearings in the base of the director lubricated with OIL, lubricating, for aircraft instruments and machine guns, through the oil cup provided. Directors M4, beginning with No. 147, have an oil filler pipe and an accessible oil hole (covered by a screw cap) in the left cover plate, eliminating the necessity for removing cover plates or cam.

(9) The constant speed motor bearings and those of the differential motors are grease-sealed and require no attention except when the director is given a general overhaul.

(10) The cover plate (small, round cap) on the left rear side of the top frame adjacent to the elevating telescope shall be removed and the angular height tracking worm greased with GREASE, special, high temperature.

(11) When the director is given a general overhaul (at intervals determined by service conditions) the bearings will be removed, cleaned with SOLVENT, dry-cleaning, and freshly coated with oil and grease.

(12) For extended operation at sustained temperature below 20 F., it will be necessary to relubricate the director with OIL, lubricating, for aircraft instruments and machine guns, only. No grease will be used. This will be accomplished by taking the director into a dust-free room and removing the four side cover plates. Ball bearings, differential gears, and gear drives will be thoroughly washed with SOLVENT, dry-cleaning, and dried. Chlorinated or other corrosive solvents will not be used. All parts will then be lubricated with OIL, lubricating, for aircraft instruments and machine guns. The oil should be

applied with a small soft brush in order to obtain a thin film. Care should be exercised so as not to touch machined parts with the hands during these operations. The director may then be assembled and should function properly at temperatures as low as 20 F.

(13) Special care of the director is required in cold or humid climates. The director must not be stored in a warm, humid room and then subjected to much lower temperatures. Under such conditions moisture will condense on the inside parts of the director and will probably cause rusting. Dry, unheated rooms are best suited for the storage of directors. Some directors are equipped with 115-volt electric lamp heaters. When instruments so equipped, are stored in humid climates or in the tropics, or in rooms where the temperature is lower than the outside atmosphere, the lamp should be kept burning if power is available. This will tend to keep the interiors dry. In storage, the directors will always be kept covered.

(14) In order to keep all bearings operating freely, the directors should be exercised once every two weeks by operating all handwheels, setting knobs, and parallax adjustment screws. Extreme care should be taken in exercising the director so as not to get it into a locked position as might happen when indiscriminately turning the handwheels. The following procedure should be used in exercising the director:

(a) With power off:

1. Turn the range setting handwheel to increase the future horizontal range to 5,000 yards.

2. Operate all handwheels (except the range setting handwheel), setting knobs, and parallax adjustment screws from stop to stop several times.

3. Set wind component velocity and target problem rate, altitude rate, and range rate dials to zero. Turn the power on.

(b) With power on (110 volt, 60 cycle A.C. electric current):

1. Turn the azimuth tracking handwheel slowly 5 or 6 revolutions.

2. Wait about 10 seconds and then turn the power off.

(15) Dismantling and lubricating antiaircraft directors will be accomplished only by personnel authorized to perform this work as prescribed in TM 9-360.

67. OIL, Castor, inhibited. - a. A white, transparent, sluggish oil used to lubricate the rubber or synthetic rubber (dermatine or neoprene) packings of hydropneumatic recoil mechanisms, including those of 155-mm and 240-mm howitzers, M1918.

68. OIL, clock. - a. Grade 1 clock oil is a fish oil with characteristic fishy odor. It is slightly yellowish in color, very fluid, with good lubricating qualities and a particular freedom from evaporation and gumming and from breaking up of the small drops, which make it especially desirable for use on small pivot bearings in clocks and fine instruments which receive lubricating attention but once or twice a year. Grade 1 should be kept in a cool place, as it becomes rancid and thick when exposed to heat. Apply with a dropper or wire. Its use should be restricted almost entirely to use on clocks and other very fine instruments inasmuch as it is quite expensive, perishable in storage, and has been supplanted by cheaper oils.

b. Grade No. 2 clock oil is a compounded oil of very thin consistency which is especially adaptable where it is desired that a non-gumming lubricant must spread over a considerable surface. Its use has been almost entirely supplanted by OIL, lubricating, for aircraft instruments and machine guns, due to its high expense, its perishable nature in storage and to recent improvements in OIL, lubricating, for aircraft instruments and machine guns.

69. ENGINE OIL. - a. Engine oil shall be used for general lubricating purposes. Lubrication charts furnished with materiel will give specific information as to the correct grade and where it should be used.

b. OIL, engine, SAE 10, shall be used to protect bores of cannon in standby condition. The gun should be cleaned after each firing period and the bore swabbed with SAE 10 oil.

c. Engine oil shall be used in the gear cases of heavy artillery. OIL, engine, SAE 30, shall be used if the prevailing temperatures are above 32 F. For temperatures below 32 F., OIL, engine, SAE 10, shall be used. This will apply in general to all gear cases on heavy artillery, for which oil is specified. However, OIL, hydraulic, shall be used in all Waterbury variable-speed gears. This comes in two grades, winter grade and summer grade, and shall be used according to climatic conditions. Ordinarily, oil should be changed twice per year. In tropical climates once per year will be sufficient, in view of the fact that only one grade will be required throughout the year. For a very low or sub-arctic temperature it may be necessary to add 10 percent by volume of SOLVENT, dry-cleaning, to the oil to lower the viscosity sufficiently to permit proper operation of the mechanism. Frequent checks for leakage or loss of lubricant from the gear cases shall be made.

70. OIL, for hydraulic variable speed gears. - Used for hydraulic variable speed gears such as gear cases on the maneuvering mechanisms of certain seacoast artillery and of large tanks.

71. OIL, lard. - a. Used for lubricating taps and dies in certain machine operations. Taps and dies are flushed from a hand oiler. It is most necessary to use lard oil when cutting threads on ferrous metals. Damage to the tap or dye and a poorly cut thread may result if it is not used. Nonferrous metals do not require the use of lard oil.

72. OIL, mineral lard. - a. A general term covering a class of compounded cutting oils. Sulphurized mineral or sulphurized mineral lard oil generally is used to produce on finished steel a surface of high degree of smoothness. Water or soluble oil generally is used to obtain a better finish with a spring tool on a lathe. Function of the cutting fluid in metal cutting operations is to cool the tool, cool the work, improve the quality of the surface produced, lubricate the surfaces in contact, clean the tool and work, flush away the chips, and to reduce the pressure of the chip on the tool. For cooling tool and work and flushing away chips, a thin soluble oil solution approximately 40-1 or solution of SODA ASH or borax in water serves the purpose best since

the quantity of fluid is of more importance in this case. As a rule, water solutions are more satisfactory as coolants than pure oil cutting fluids. Oil containing a large percentage of sulphur tends to reduce the tendency of steel chips to weld to the tool, and helps produce a higher quality of machine finish.

b. In lieu of OIL, mineral lard, listed in SNL K-1, water solutions of SODA ASH or borax in water may be used. For use on small lathes and cutting tools on ordnance maintenance vehicles, oil is preferred to other cutting fluids because it does not tend to corrode equipment and material as rapidly as water solutions. The above mentioned SODA ASH and borax solutions should be made from clean water to which 1 1/2 percent by weight of one or the other of these materials has been added.

(1) Used for cooling and lubricating metal-cutting parts of machine tools. The oil is pumped over the cutting edge of the tool.

73. OIL, lubricating, for aircraft instruments and machine guns. - a. A very fluid, pure petroleum oil for lubricating small arms over a wide temperature range, giving satisfactory lubrication at very low temperatures if properly applied. As a lubricant it does not supplant OIL, sperm, which should be used for the lubrication of ground machine guns when the temperature is above 45 F.

b. It has practically no rust preventive properties and OIL sperm, or in lieu of this OIL, engine, SAE 10, or OIL, engine, SAE 30 (SAE 30 for higher temperatures), should be used to protect the bores of small arms against corrosion for short periods of time. OIL, lubricating, for aircraft instruments and machine guns, USA 2-27, shall be used in the buffer mechanisms of ground machine guns and antiaircraft machine guns, and is used to fill the oil buffer mechanisms of all caliber .50 machine guns.

74. OIL, lubricating, car and locomotive engine. - a. A very fluid oil used in journal boxes of railway artillery.

b. Used with wool waste supplied for this purpose, the waste being soaked in the oil prior to use.

c. Avoid loose ends and lumpiness in packing. Maintain proper oil level in journal, but avoid a "flooded" condition.

75. OIL, lubricating, steam cylinder, mineral, spec. VV-O-611. (Navy contract, symbol No. 5190). - a. Use is restricted to arsenal and maintenance shops for use on steam engines in automatic lubricating devices, etc.

76. OIL, lubricating, chain and wire rope. - a. Very heavy lubricating oil having the consistency of grease at ordinary temperatures. Used to lubricate and protect gears, chains, and wire ropes, as on the loading apparatus of the 14-inch railroad mount M1920 and similar equipment. It should be warmed to the temperature of boiling water to facilitate its application.

77. OIL, quenching. - a. Used for quenching articles in heat treatment.

b. A special oil with high flash point used as a bath in which to heat articles for low-temperature drawing heat treatment.

77½. OIL, sperm. - a. Used as a lubricant and a corrosion preventive on small arms. Should be used to protect weapons from corrosion if they are left unused for more than a few hours. In lieu of OIL, sperm, OIL, lubricating, for aircraft instruments and machine guns will be used to protect against corrosion. Below 45 F., OIL, lubricating, for aircraft instruments and machine guns will be used to lubricate small arms. It must be understood, however, that OIL, lubricating, for aircraft instruments and machine guns will not afford adequate protection against corrosion for more than a few hours under severe weather conditions while OIL, sperm, will protect properly oiled weapons for two or three days under similar circumstances.

78. PETROLATUM. - a. Will be used to some extent in ordnance maintenance shops. However, its use on worm gears of fire control and sighting instruments has been superseded by GREASE, special, low temperature. Henceforth, all parts of fire control instruments for which solid or semi-fluid greases and PETROLATUM have been recommended will be lubricated with GREASE, special, low temperature. Lubricants for fire control instruments function also as rust preventives. It is important that they be applied carefully and diligently, extreme care being taken not to overlubricate the instrument.

SECTION VI
FLUIDS FOR RECOIL MECHANISMS AND HYDRAULIC JACKS

79. ALCOHOL, denatured. - a. A clear liquid with inflammable and toxic properties.

b. Formerly used in some hydraulic jacks. A mixture of 2 parts ALCOHOL, denatured, and 3 parts clean water is used. For very low temperatures (below 40 F.) the alcohol-water ratio should be 3 parts denatured alcohol to 2 parts water. Grain alcohol may still be used and the concentrations listed above will apply. However, the use of alcohol in hydraulic jacks should be restricted for the most part to emergency only. (see par. c. below).

c. The liquid now prescribed for filling hydraulic jacks is OIL, lubricating, for aircraft instruments and machine guns, with but one exception, namely: Raritan Arsenal will issue grain alcohol until the supply on hand is exhausted. All other depots will issue OIL, lubricating, for aircraft instruments and machine guns. Under no circumstances should liquids other than OIL, lubricating, for aircraft instruments and machine guns, or the alcohol issued by Raritan Arsenal, be used.

d. Denatured alcohol may be used in preparation of REMOVER, paint and varnish.

80. GLYCERIN, grade A, USP. - a. Used mixed with an equal volume of water, in recoil and counterrecoil mechanisms of the following carriages:

155-mm howitzer carriage, M1917 (Schneider)
155-mm howitzer carriage, M1917A1
155-mm howitzer carriage, M1918
155-mm howitzer carriage, M1918A1
240-mm howitzer carriage, M1918

240-mm howitzer carriage, M1918A1
12 inch mortar carriage, M1918
12 inch gun railway carriage, M1918 (Batignolleo)
14 inch gun railway mount, M1920
16 inch howitzer carriage, M1920
16 inch barbette carriage, M1919
16 inch barbette carriage, M1919M1

b. The following formula for glycerin-water mixture will be used for all carriages. Other formulae, as found in manuals for the various carriages, should not be used unless they conform to this formula:

Neutral glycerin, 50 parts by volume
Pure water, 50 parts by volume
To each 3 gallons of the mixture add 1 ounce of SODIUM HYDROXIDE, CP, (NaOH),(1 pound caustic to 48 gallons).

(1) With glycerin registering 28.5 Baume at a temperature of plus 15 C., the mixed solution will have a specific gravity of 1.135 and will test 17.5 to 18 Baume hydrometer when at a temperature of plus 15 C. (59 F.)

c. This recoil fluid will not function properly at arctic temperatures. The changing of the formula must not be attempted for any reason. Either raising or lowering the glycerin content will change the specific gravity and viscosity considerably. Where arctic temperatures prevail the temperature of the recoil mechanism should be maintained at a temperature above plus 10 F., if practicable, in order to avoid injury to materiel or personnel during firing.

d. Increase of sodium hydroxide content above that specified in the formula will destroy leather or other packings. Glycerin-water recoil liquid should be replaced with fresh liquid whenever it is found necessary to drain cylinders. Drainings will be conserved for use in preparing sponging solution for cold weather but due to the alkali content it must not be used as an antifreeze coolant in car or truck radiators. Its use as a coolant would result in quick destruction of the radiator. In

cases of emergency the old liquid may be strained and used for refilling of the recoil mechanism.

e. The liquid should be strained through a clean piece of linen or muslin before using.

f. Water sufficiently pure for use in storage batteries, such as filtered rain water, will be used. In case of doubt, use distilled water.

81. RECOIL OIL. - a. General. Recoil oils are carefully selected for their physical and chemical properties. The clearances of the recoil mechanisms are fixed according to the characteristics of the oil. Therefore, the greatest care must be taken not to use any oil in a recoil mechanism except the grade and kind prescribed for it. The specific recoil oil to be used with a given materiel will be specified in the technical manual published for the materiel in question. Only the oils prescribed for a given unit, in pertinent technical manuals may be used in that unit.

(1) Water in recoil oils. - (a) It is important that no water be introduced into recoil mechanisms that use recoil oil, as it greatly increases the rate of corrosion and may result in pitting of the finished surfaces, interfering with the functions of the recuperator and reducing its normal, serviceable life.

(b) Unfortunately, in spite of the great care taken in preparation and shipping the medium and heavy recoil oils, water is often found in them. Exposure in an open can, even if the top be covered with a cloth, will likely result in accumulation of moisture from the air. Condensation in a container partly filled with oil, or pouring from one container to another which has moisture on its inner walls, results in moisture being carried along with the oil into recoil mechanisms.

(c) Therefore, it is advisable that organization commanders test the recoil oil on hand for water content. If a clean glass bottle of about 1 pint capacity be filled with the recoil oil and allowed to settle, the water, being heavier than

the oil, will sink to the bottom and, with the bottle slightly tilted, will form drops or bubbles in the lower corner. If the bottle be then inverted with this corner uppermost and the bottle held to the light, such drops or bubbles may be seen slowly sinking in the oil. If the oil has a cloudy appearance when looked through against a light, the cloudiness may be ascribed to minute particles of water in suspension. If a shallow pan of the oil be heated over a gas jet to the temperature of boiling water any water in the oil will appear on the surface as minute bubbles. This test will disclose the presence of water which the settling test will not detect.

(d) Should any of these tests show water in the oil, all oil on hand should be turned in for exchange, as there is no practical way of extracting the water or dehydrating the oil except at a depot equipped with special machinery for the purpose. Most large electrical plants have equipment for dehydrating transformer oil and will usually undertake to dry recoil oils (in quantities exceeding 5 gallons) for a small charge. The process consists in forcing the oil under a pressure of 80 to 100 pounds per square inch through specially prepared blotter paper which retains the moisture. Another suggested method of removing water from oil is by means of a centrifuge.

(e) Settling alone is insufficient to remove water and boiling affects the characteristics of the oil.

(2) Care of recoil oil. - a. The transfer of recoil oil from one container to another which may not be properly marked with the exact name of the oil as listed in SNL K-1 results in wrong oil getting into recoil mechanisms, or in the use of recoil oil for lubricating purposes, etc. Recoil oil must not be put into any container not plainly and durably marked with the exact (ordnance) name for the oil.

The following rules should also be scrupulously observed:

(a) Recoil oils should never be left in open containers.

(b) Recoil oils must not be subjected to excessive heat.

(c) The greatest care must be taken with recoil oils to exclude moisture and dirt.

(d) Test recoil oils for moisture, and strain through clean cloth before inserting in any recoil mechanism.

(e) Do not mix recoil oils with any other type of oil or use any other kind of oil in a recoil mechanism than that prescribed for that particular mechanism.

SECTION VII

WELDING, BRAZING, LUBRICATING AND WELDING MATERIALS

82. ACID, muriatic. (Commercial hydrochloric acid) - a. A solution of hydrogen chloride gas in water. Clear, colorless, strongly fuming liquid with pungent odor. Poison.

b. Used in making a flux for soldering. The flux is prepared as follows: Pieces of ZINC, mossy, commercial, are dropped into a small quantity of the acid and are dissolved by it. When action between the liquid and the zinc ceases the solution is ready for use. Excess zinc is allowed to remain in the solution. The flux thus prepared is actually a solution of zinc chloride in hydrochloric acid. It is more poisonous and dangerous to handle than hydrochloric acid. It will destroy tissue very rapidly and if some accident results in its contact with the skin or eyes, it must be immediately washed off with copious amounts of water. The solution is used mostly for soldering iron and steel. Metallic zinc scraps, wire, sheet, cast, or rolled will be quite satisfactory if it is definitely known that the scrap metal is zinc. However, if there is any doubt, mossy zinc should be used in the preparation of soldering flux.

c. Keep the flux in a tightly closed container and do not store in a place where the fumes can come in contact with tools

or shop equipment, since the fumes are quite destructive from the standpoint of corrosion.

83. CALCIUM CARBIDE. - a. Used in acetylene generators for generating acetylene gas. The use of acetylene generated from calcium carbide in small generators has been largely supplanted by the more convenient and less hazardous practice of using cylinders of acetylene gas. Acetylene is no longer used to any extent for lighting purposes, its use being almost entirely confined to welding, brazing, and cutting operations. Acetylene gas is highly explosive and toxic and due precaution must be taken to avoid accident.

b. Calcium carbide reacts rapidly with water and must be kept in a tightly closed can. The generators are so arranged that water drops slowly on the carbide, resulting in the generation and release of acetylene gas.

c. Acetylene may explode spontaneously if stored in gaseous form in containers other than the special acetylene cylinders authorized by law. For this reason acetylene, other than that bought in cylinders, must be generated continuously as used.

84. GASES. Gases considered herewith are compressed air, acetylene, oxygen, hydrogen, nitrogen, and carbon dioxide. However, the same principles apply to all gases handled in cylinders.

a. Air, compressed. Compressed air is used by ordnance maintenance companies for operating pneumatic tools, such as rivet sets, chipping chisels, and air hammers. Also, where proper equipment is available it can be used in lieu of nitrogen for recharging hydropneumatic recoil mechanisms which take the glycerin-and-water mixture.

b. HYDROGEN, compressed. For filling balloons used in antiaircraft target practice. The balloons are filled directly from the hydrogen cylinder.

c. NITROGEN, 99.5%. Used by authorized shops only, to recharge hydropneumatic recoil mechanisms using recoil oil. Great care must be exercised in filling the shipping cylinders, to prevent entry of free moisture. Similar care is necessary in filling recoil mechanisms to insure dryness of mechanism bore

and communicating pipes. Thus, in reassembling hydropneumatic mechanisms, such as the Puteaux, nitrogen is introduced into the mechanism (at about 200 pounds pressure) and allowed to stand a few hours, after which the pipe or filling tube is disconnected at the shipping container and the pressure of 200 pounds allowed to blow out before final filling. These precautions are of course not necessary when filling either the 155-mm or 240-mm howitzer recoil mechanisms, in which a mixture of glycerin and water is used.

d. ACETYLENE, compressed, for welding. Its use is restricted for the most part to ordnance maintenance shops for welding, brazing, and cutting operations. It may be used in the field only by specifically trained and authorized personnel.

e. OXYGEN, compressed. Its use is restricted to ordnance maintenance shops by authorized personnel. Used in connection with acetylene welding, cutting and brazing.

85. GAS CYLINDERS. - a. The following are general precautions to be observed with all gas filled cylinders. Cylinders should be kept upright at all times and be wired or fastened in position so as not to bump against each other during transit. They must not be subjected to extremes of temperature. Cylinders must never be heated in order to expel remaining gases inasmuch as the temperature may be sufficient to cause the cylinders to explode. This is a matter of pressure and therefore not one limited to explosive gases, although in the case of the latter the hazard is greatly increased. Cases are on record where the application of heat has raised the pressure in cylinders of CARBON DIOXIDE sufficiently to cause rupture of the cylinder and injury to personnel. This practice of heating cylinders to expel gas must therefore cease if it still persists, regardless of whether or not the gas is inert.

b. Care of oxygen and acetylene cylinders. (1) Handle with care. Never drop cylinders nor permit them to strike each other violently.

(2) Handling with cranes. Never use a lifting magnet or a sling (rope or chain) when handling cylinders. A crane may be used when a safe cradle or platform is provided to hold the cylinders.

(3) Returning cylinders. When returning empty cylinders, remove lower portion of the shipping tag attached to the cylinder. Bill of lading should specify number of cylinders, cylinder serial number, consignee and fact that the cylinders are empty. A copy of bill of lading should be sent to the consignee. Close valve before shipment. See that protective caps for cylinders and nuts for valve outlets are replaced before shipping empties.

(4) Interstate Commerce Commission. Only cylinders approved for use in interstate commerce shall be used for the transportation of compressed gases.

c. Use of cylinders - (1) Cylinder caps. Where caps are provided for valve protection, such caps should be kept on cylinders except when cylinders are in use.

(2) Filling cylinders. Cylinders must not be filled except by or with consent of the owner and then only in accordance with the regulations of the Interstate Commerce Commission. Never attempt to mix gases in a cylinder.

(3) Illegal to change marks. It is illegal to remove or change the numbers or marks stamped on cylinders without written authority from the Bureau of Explosives, New York City.

(4) Don't use as support. Never use cylinders for rollers, supports, or for any purpose other than to carry gas.

(5) Don't disturb safety devices. Never tamper with the safety devices in valves or cylinders.

(6) Open slowly without wrench. Open cylinder valves slowly. Never use wrenches or tools except those provided or approved by the gas manufacturer.

(7) Threads must match. Make sure that the threads on regulators or other unions are the same as those on cylinder valve outlets. Never force connections that do not fit.

(8) Don't interchange regulators. Regulators and pressure gages provided for use with a particular gas must not be used on cylinders containing different gases.

(9) Don't repair. Never attempt to repair or alter cylinders or valves.

(10) Don't repair a leaky cylinder. Should a leak occur in a cylinder, take the cylinder into the open air, and exhaust the gas slowly, keeping well away from fires or open lights. Close the valve, replace the cap, notify the manufacturer immediately, giving serial number of cylinder and particulars of defect as far as known, and await shipping instructions.

d. Storage. - (1) Keep cylinders at normal temperature. All cylinders should be protected against excessive rise of temperature. Cylinders may be stored in the open, but in such cases should be protected against extremes of weather. During winter, cylinders stored in the open should be protected against accumulation of ice and snow. In summer, cylinders stored in the open should be screened against direct rays of sun.

(2) Don't store near inflammables. Never store cylinders near highly inflammable substances, such as oil, gasoline, waste, etc.

(3) Avoid damp. Cylinders should not be exposed to continuous dampness.

(4) Separate "fulls" and "empties". Store full and empty cylinders apart and mark the latter "M.T." with chalk and on the tag attached to the cylinder.

(5) Use in order of receipt. Cylinders should be used in the order received. Avoid as far as possible keeping reserve cylinders in stock a long time. This will eliminate unnecessary cylinder rental charges and reduce the possibility of loss of gas by leakage.

(6) Return promptly. Cylinders must be returned as soon as empty and orders should be placed in quantities commensurate with user's immediate requirements. The customer is held responsible for the safe return of all cylinders within 30 days.

(7) Store in safe place. Do not store full cylinders near elevators or gangways, or in locations where heavy moving objects may strike or fall on them.

e. Use of oxygen cylinders. - (1) Avoid oil and grease. Never permit oil or grease to come in contact with oxygen cylinders, valves, regulators, gages, or fittings. Do not handle oxygen cylinders or apparatus with oily hands or gloves.

(2) Always use a regulator. Never use oxygen from a cylinder without reducing the pressure through a suitable regulator intended for that purpose.

(3) Blow out dirt. After removing valve cap, open valve an instant to clear opening of particles of dust or dirt.

(4) Opening valve. If valve is difficult to open, point the valve opening away from you and use greater force. Avoid, however, the use of a wrench on valves equipped with hand wheels.

(5) Attaching regulator. After attaching regulator and before cylinder valve is opened see that adjusting screw of the regulator is released.

(6) Open valve slowly. Never permit oxygen to enter the regulator suddenly. Open cylinder valve slowly.

(7) Pressure varies with temperature. Increase in temperature of a cylinder of gas will result in a corresponding increase in pressure. For this reason cylinders should always be protected from direct rays of the sun or from other sources of heat.

(8) Before removing regulator. Before regulator is moved from a cylinder close the cylinder valve and release all gas from regulator.

(9) Keep sparks and flame away. Avoid sparks or flame from welding or cutting torch coming in contact with cylinders.

(10) Never interchange equipment. Never interchange oxygen regulators, hose, or other appliances with similar equipment intended for use with other gases.

(11) Manifolding oxygen cylinders. Danger in using improperly designed manifolds. Where oxygen cylinders are connected to manifolds or headers, such manifolds must be of proper design and equipped with one or more pressure regulators. The experience of the industry has conclusively proved that the usual consumer of oxygen cannot know from his own experience how to design and construct proper manifolds and service pipe lines; and unless they are properly designed and constructed, the state and municipal bureaus, as well as the constituted safety bureaus and insurance companies, will not accept their use. Serious accidents which have occurred in the past make necessary this supervision and approval by the above authorities. Oxygen manufacturers will be glad to furnish specifications for construction and installation of proper oxygen manifolds and pipe lines.

(12) Do not handle fittings with greasy hands. Where oxygen manifolds and cylinders are located, care should be taken to avoid handling the manifold fittings and connections and oxygen cylinder valves with greasy or dirty hands.

(13) Open valve wide. Fully open the cylinder valve when cylinder is in use.

(14) Don't mix gases. Never attempt to mix gases in an oxygen cylinder.

(15) Don't use oxygen as compressed air. Never use oxygen as a substitute for compressed air. It is dangerous to use oxygen for pneumatic tools, to start Diesel engines, for creating pressure in oil reservoirs, for paint spraying, for blowing out pipe lines, etc.

(16) Don't store near inflammables. Do not store cylinders near inflammable material, especially oil, grease, or any substance likely to cause or accelerate fire. Oxygen is not inflammable, but supports combustion.

(17) Don't mix reserve stocks. Do not store reserve stocks of cylinders containing oxygen with reserve stocks of cylinders containing combustible gases. They should be separately grouped.

f. Acetylene cylinders. (1) Keep upright. Acetylene cylinders should be used and stored in an upright position to avoid possibility of drawing out acetone.

(2) Don't exceed 15 pounds per square inch. Acetylene should never be used at a pressure exceeding 15 pounds per square inch.

(3) Protect from sparks and flame. Keep sparks and flame away from acetylene cylinders. Never use an open flame near cylinders for any purpose whatsoever. If it is necessary to carry a lighted torch to the cylinder for readjustment of the regulators, hold the torch with one hand as far away from the cylinders as possible, pointing the flame away.

(4) Always use regulator. Never use acetylene from cylinders through blowpipes or other devices equipped with shut-off valves on the acetylene supply connections without reducing the pressure through a suitable regulator to the cylinder valve.

(5) Blow out dirt. After removing valve cap, open valve an instant to clear opening of particles of dust or dirt.

(6) Attaching regulator. After attaching regulator and before cylinder valve is opened, see that adjusting screw of the regulator is released.

(7) Point valve outlet away. Turn the acetylene cylinder so that its valve outlet will point away from the oxygen cylinder.

(8) Open cylinder valve one full turn only. Do not open cylinder valve more than one full turn.

(9) Before removing regulator. Before regulator is removed from a cylinder close the cylinder valve and release all gas from regulator.

(10) Never interchange equipment. Never interchange acetylene regulators, hose, or other appliances with similar equipment intended for use with other gases.

(11) Don't transfer gases. Never attempt to transfer acetylene from one cylinder to another or to mix any other gas with it in the cylinder.

(12) Manifolds. Never use manifolds for acetylene cylinders unless constructed upon the advice of a qualified acetylene engineer.

(13) Keep key in valve when using. The wrench used for opening the cylinder valve should always be kept on the valve spindle when cylinder is in use.

(14) Close valves. When returning empty cylinders see that valves are closed to prevent evaporation of acetone.

(15) Don't refill. Never under any circumstances attempt to refill acetylene cylinder.

(16) Contents by weight. The pressure in an acetylene cylinder does not accurately indicate the amount of gas contained therein. The amount is determined by weight.

(17) Testing for leaks. Never test for acetylene leaks with an open flame. Use soapy water.

g. Storage. (1) Don't mix reserve stocks. Do not store reserve stocks of cylinders containing acetylene with reserve stocks of cylinders containing oxygen. They should be seperately grouped.

h. Use of combustible gases. (1) Keep sparks and flames away from cylinders.

(2) Connections to piping, regulators, and other appliances should always be kept tight to prevent leaking.

(3) Never use an open flame to detect combustible gas leaks. Use soapy water.

(4) When cylinders are not in use, keep valves tightly closed.

(5) Never use combustible gases from cylinders without reducing the pressure through a suitable regulator attached directly to the cylinder.

(6) After removing valve cap, open valve an instant to clear opening of particles of dust or dirt.

(7) If valve is difficult to open, point the valve opening away from you, and use greater force. Avoid, however, the use of a wrench on valves equipped with hand wheels.

(8) After attaching regulator and before opening cylinder valve, see that adjusting screw of regulator is released.

(9) Never permit the gas to enter the regulator suddenly. Open the cylinder valve slowly.

(10) Before regulator is removed from a cylinder, close the cylinder valve and release all the gas from regulator.

(11) Manifolds for combustible gases should be used only if they are designed by qualified engineers. Gas manufacturers will furnish specifications for construction and installation of suitable manifolds.

(12) Never interchange combustible gas regulators, hose, or other appliances with similar equipment intended for use with other gases.

(13) Store all cylinders containing combustible gases in a well ventilated place.

(14) Do not store reserve stocks of cylinders containing combustible gases with cylinders containing oxygen. They should be separately grouped.

86. FLUXES AND WELDING COMPOUNDS. - a. These materials serve the purpose of cleaning the surface and of preventing excessive oxidation during the fusion of metals. With the possible exception of materials used in soldering operations their use will be restricted to highly trained ordnance personnel.

87. PASTE, soldering - a. An acid-free flux in paste form used in soldering.

88. ROSIN - a. Used as a reducing agent to keep surfaces free of oxidation products while soldering.

89. SAL AMMONIAC (ammonium chloride) - a. Used to clean soldering iron preparatory to tinning the iron.

90. SALT, soldering - a. A non-acid flux of the consistency of table salt.

b. Used to clean tin or tin-plated articles, such as tin ammunition cases, preparatory to applying the solder.

c. Generally to be diluted with about 3 parts of clean water to 1 pint of SALT, soldering, and applied with a brush.

91. WELDING. - a. Detailed instructions for electric and oxyacetelene welding are to be found in OFSB 5-2. Tests for identifying metals, general information on welding and cutting equipment and operations involving their use, specific information on welding of metals used in ordnance construction, and general precautions to be observed in welding are thoroughly covered. Technical Manual 1-430 also gives detailed information with respect to welding. The welding of a large number of different alloys is covered in this technical manual.

SECTION VIII
MISCELLANEOUS

92. BRUSHES - CARE, PRESERVATION, AND USE. - a. It is desirable that paint be removed from brushes immediately after the painting job is finished. However, if the painting operation is to extend over a period of several days or even weeks the brushes may be protected overnight by suspending in a container of fresh water. If the brush is not to be used again for an indefinite period, paint must be thoroughly cleaned from the brush before it dries. SOLVENT, dry cleaning, or TURPENTINE will serve this purpose very well. After being thoroughly cleaned, brushes should be laid flat on a horizontal surface and protected from

attack by moths. Brushes in storage should be protected by naphthalene.

b. Paint brushes may be kept in excellent condition by drilling small holes through the handles and inserting a wire through them in such a manner that they can be suspended in a can of drained crankcase oil. Brushes so suspended should not touch the bottom of the can, and the bristles should be completely covered with oil. It will, of course, be necessary before painting to clean the brush thoroughly. Cleaning is best accomplished by wiping and draining most of the oil from the brush and then washing it in SOLVENT, dry cleaning, or similar material.

c. BRUSH, mottling, No. 2 (7/8"). (1) Bristles project about 1" from ferrule and the over-all length of brush is about 5 1/4".

(2) Used for cleaning sights, position finders, and the like.

d. BRUSH, artist's, camel's hair, round, No. 1 (small end of ferrule about 3/16" diameter). Used for cleaning the lenses of optical instruments, painting around oil holes, and for lacquering small surfaces. Brushes used on optical instruments must be used for that purpose only. In no event should a brush that has previously been used for painting or lacquering be used on optics.

e. The uses of the various grades and sizes of cleaning or painting brushes will not be discussed further here in view of the fact that their application and use is so obvious.

f. Old and worn paint brushes properly cleaned should be used to apply rust preventive compounds.

93. CARBON DIOXIDE FOR FIRE EXTINGUISHERS. - a. For reasons of economy carbon dioxide gas in 50 pound containers will be used by the ordnance shops for recharging the small (4-pound) extinguishers. Repairs necessary will also be made at the ordnance shop. Replacement parts for extinguishers, charging equipment, and carbon dioxide gas are listed in the appropriate sections of SNL K-2. Parts for recharging extinguishers will be supplied to stations where the number of extinguishers will justify the

cost of equipment. In cases where the number of extinguishers does not justify the cost they should be serviced at the nearest ordnance shop or civilian establishment that has the facilities.

94. CHALK. - a. Chalk, blue, railroad, 1" x 4". Used for marking purposes to distinguish from previous white chalk marking or on surfaces on which white chalk marks are not plainly seen.

b. Chalk, white, railroad, 1" x 4". Used for general marking purposes, sight lines, etc.

c. Chalk, white marking, lump. Used in shop to cover surfaces preparatory to laying out dimensions and for general temporary marking purposes.

95. COMPOUND, antiseize, mica base. - a. Used on some threaded fittings in automotive and aeronautical engine assemblies. Typical application is on spark-plug threads and similar units to prevent corrosion and sticking and to facilitate disassembly.

96. COMPOUND, antiseize, white lead base, for threaded fittings in seacoast guns, etc. - a. Used in same manner and for purposes similar to those outlined in par. 5 above. Lubricates threads during assembly, protects against corrosion, and tends to form an airtight and easily disassembled unit. It can be used to advantage on bolts and similar threaded parts of seacoast guns that are exposed to severe weathering conditions and its use is recommended on aluminum or aluminum alloy threaded parts, threaded steel parts under considerable strain, and on threaded parts subject to frequent adjustment.

b. The compound should be stirred well before being applied and should not be applied in excessive quantities. Application should be made on male fittings only.

97. DRESSING, belt. - a. Used to increase the adhesion of a machine belt to its pulleys.

98. DRESSING, russet leather. - a. A preparation of beeswax and TURPENTINE (sometimes erroneously referred to as an equipment dressing), 67 percent yellow beeswax, 33 percent TURPENTINE.

b. Used as a polish for leather equipment, especially holsters and gun slings. After cleaning and the application of OIL, neat's-foot, the leather is rubbed until the oil is nearly removed from the grain side of the leather. The russet-leather dressing is then applied sparingly and rubbed to a polish. Scars, cuts, or abrasions of the leather may be improved in appearance, though not obliterated, by such use of the russet-leather dressing.

99. ETHYLENE CLYCOL. - a. An antifreeze solution, miscible with water in all proportions.

b. Used in jackets of machine guns where arctic temperatures prevail. It is satisfactory for temperatures as low as -60 F. It is highly important that the proper proportions of ethylene glycol and water be maintained. Protection against freezing at temperatures as low as -62 F., can be obtained with a mixture consisting of 60 percent by volume of ethylene glycol and 40 percent by volume of water. More or less water than this amount in the mixture will give a freezing temperature above -62 F.

c. In lieu of ethylene glycol it will be satisfactory to use OIL, engine, SAE 10, or even drained crankcase oil of similar viscosity in jackets of machine guns. This latter should be strained through a piece of muslin, before it is used.

100. FLASK, Florence, 1-liter capacity. - a. These flasks are used as containers of material for water targets used in connection with aircraft bombing practice. This thin glass flask is dropped by the aircraft. When it strikes the water the flask breaks and the material spreads out over an area and in comparatively smooth water forms a suitable target for bombing practice.

101. KNIFE, putty. - a. Used to force putty into cracks and crevices of material preparatory to painting, and to scrape off old paint.

102. LIQUID, fire extinguishing. - a. For plunger type fire extinguishers. Carbon tetrachloride base.

b. Used to refill extinguishers. The fumes generated in extinguishing fire with this liquid are intensely irritating and are also poisonous. Care should, therefore, be exercised in using it in confined spaces. Keep the container tightly closed.

If this type of extinguisher is not kept completely filled, the space above the liquid may permit the entrance of air and water vapor with subsequent formation of small amounts of hydrochloric acid. The acid will attack metal of extinguisher and render it unserviceable. For this reason, extinguishers should be checked and filled at least once a month and in the event an extinguisher is used, a report should be made immediately to the proper authorities so that it can be refilled.

103. NEEDLE, sacking. - a. A heavy needle about 5 inches long with a wide eye for twine.

b. Used for sewing burlap on sponges used for cleaning the bores of cannon.

104. PAINT, blue marking, semipaste. - a. Prussian blue pigment in oil.

b. Used as a marking material in the operation of fitting bearings, etc.

105. PALM, sewing, sailmaker's. - a. Used to protect the hand when using the sacking needle.

106. PAPER, litmus. - a. PAPER, litmus, is made by impregnating a suitable paper with litmus, an organic dye. The coloring matter of litmus is red and its alkaline salts are blue. This property of litmus paper causes it to turn red if immersed in an acid solution, and blue if immersed in an alkaline solution. Thus blue litmus turns red in acid solution and remains blue in an alkaline solution or in a neutral solution, while red litmus paper turns blue in alkaline solution and remains red in a neutral solution. It should be noted that both red and blue paper are necessary to indicate a neutral solution. Red litmus may be converted into blue litmus and vice versa, by exposing the paper at hand to moisture and then exposing same to the fumes of ammonia or acid respectively, as the case may be. Litmus will be used in testing water-glycerin solution used in recoil mechanisms. It should be

remembered in this instance that the glycerin-water mixture for recoil mechanism should always be on the alkaline side. (The solution should turn red litmus blue). Failure to have the solution alkaline will result in extreme corrosion of the recoil mechanism. More sodium hydroxide than the amount recommended in par. 60 will result in destruction of the leather or packings.

107. CYANIDE POTASSIUM. - a. Poison. A powdered, white-or-brown tinged substance. It is deliquescent and may take up enough moisture to become partially liquefied if allowed to stand in open containers.

b. Used in the case-hardening of steel parts. The metal part is heated to a bright red and the part to be hardened immersed in or rubbed with the cyanide, which melts at the contact. Carbon is released from the chemical and enters the iron, forming a thin layer of carbon steel on the surface, which hardens when quenched in water.

c. The poisonous and toxic nature of potassium cyanide is increased greatly if it is allowed to come in contact with acid, since contact with acid will result in the release of a very deadly gas, hydrogen cyanide. It is obvious that every precaution should be taken to keep the material clean and dry and away from acid or other chemicals. Keep the container covered when not in use.

108. RUBBER STOPPERS. - a. Used to close the chamber of small arms and machine guns when using the metal-fouling solution.

109. RUBBER TUBING. - a. Two-inch section. Used on the muzzle end of small arms and machine gun barrels to retain the metal-fouling solution during cleaning.

110. TWINE, jute. - a. Used for sewing burlap covering on the sponges used for cleaning bores of cannon.

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BY ORDER OF THE SECRETARY OF WAR

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E. S. ADAMS,
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The Adjutant General.

G. C. MARSHALL,
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